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Quarterly Journal of Science N° XIII

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Chas Lyell

THE QUARTERLY
JOURNAL OF SCIENCE.

JANUARY, 1867.

I. SIR CHARLES LYELL AND MODERN GEOLOGY.

Of late years the attention of a large number of geologists has been directed to an examination of the nature and potency of the causes of change now operating on the surface of the earth. This course of observation was first firmly trodden by Sir Charles Lyell; and now that we are reposing for a time after a series of controversies on subaerial forces, it may be useful to give a sketch of the services which have been rendered to science by the philosopher who, thirty-six years ago, founded the now dominant school of Geology.

In 1830 Sir Charles Lyell published the first volume of the first edition of the 'Principles of Geology.' As stated on the title-page, it was "an attempt to explain the former changes of the earth's surface by reference to causes now in action." This great work at once established Sir Charles Lyell's reputation as a philosophical geologist of the highest order; more than that, it produced the 'Uniformitarian' school of geology, to which belong nearly the whole of the distinguished geologists of the present day, who at that time were but students of the science. Mr. Darwin expects that the younger zoologists will hereafter confirm his theory of Natural Selection; but Sir Charles Lyell can say that the younger geologists of thirty years ago have done this for the doctrine of Uniformity. In fact, soon after its publication, Lyell's 'Principles' became a household book; and although much that it contained met with opposition from some of the leading geologists of the day, that did not prevent the great body of their successors from accepting it as their guide and text-book in geological reasoning. The Royal Society also "crowned" the work by awarding a Royal Medal to its author the year after its completion (1834).

To future generations of geologists, Sir Charles Lyell's reputation will chiefly depend upon their estimate of the effect produced on the scientific world by the publication of the first edition of the 'Principles.' Even at this distance of time it is difficult to form a correct and impartial estimate of what geology would have been had the 'Principles' never been published. The chief design of the work was to uphold and strengthen the Huttonian doctrine of uniformity in the causes which have operated, and the phenomena which have been produced, throughout all geological time. The antagonistic doctrine of cataclysms was dominant, if not universally received, at the time of its publication, and is even now not quite extinct amongst some of the older geologists; although it is altogether ignored by those to whom in early days the 'Principles' has been a geological catechism. Still, the chief geologists of that day united in bearing testimony to the great value of the book, and it may be useful to quote a few of the opinions then expressed by men whose writings are still referred to with respect.

Dr. Whewell, in his 'History of the Inductive Sciences,' frequently discusses the 'Principles,' and in reference to causes of change he remarks that it may "be looked upon as the beginning of Geological Dynamics, at least among us. Such generalizations and applications as it contains give the most lively interest to a thousand observations respecting rivers and floods, mountains and morasses, which otherwise appear without aim or meaning."* The Rev. W. D. Conybeare, in his report on Geology to the second meeting of the British Association, says that it is "in itself sufficiently important to mark almost a new æra in the progress of our science;"† and Dr. Fitton considered it one of the most popular books, "and certainly one of the most valuable that has appeared since Mr. Playfair's well-known 'Illustrations of the Huttonian Theory.'"‡

Perhaps the most graceful allusion to the merits of the 'Principles' is contained in Mr. Poullett Scrope's dedication to Sir Charles Lyell of the second edition of his work on Volcanoes, published in 1862. This distinguished geologist then wrote, "When the first edition of this work [Volcanoes] saw the light, now *seven-and thirty years ago*, ... you expressed a warmer interest in, and more agreement with, the views it contained than they met with from the bulk of our associates. It was an attempt to investigate one important class of the agencies of change now in operation on the earth's surface, and to trace their analogy, or rather identity, with those which have apparently prevailed through earlier geological periods—a portion, in fact, of the great task at which you have so long laboured, as respects the entire range of terrestrial phenomena, *with an originality, persistence, and success that have placed you by common consent at the head of the followers of the science.*" This dedication was written only four years ago, and is on that account more valuable, as showing the estimation in which so eminent a geologist, who has seen the full effects of the 'Principles,' holds that work and its author.

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* Op. cit., vol. iii., p. 552.

† 'Rep. Brit. Assoc.,' 1832, p. 406.

‡ 'Edinburgh Review,' vol. lxix., No. 140, p. 406. 1839.

Although Dr. Whewell, Mr. Conybeare, and others united in recognizing the importance and merit of the 'Principles' in a general way, most of the geologists of five-and-thirty years ago also joined with them in declaring that Sir Charles Lyell went too far; that the doctrine of uniformity does not hold good when applied to remote epochs; but that, for instance, the metamorphic rocks were altered by agencies of far greater intensity than any that prevail at the present day. They contended that although the forces which formerly produced changes on the surface of the globe were in bygone times the same in kind as they are now, they were different in degree. Sir Charles Lyell, on the other hand, has persistently maintained that we have no evidence to warrant us in assuming those forces to have possessed greater intensity than at present during any geological period, and that until such evidence is discovered we have no right to attempt to explain past events by reference to causes of greater intensity than now operate at and beneath the surface of the earth. In the first chapter of the 'Principles,' Sir Charles Lyell quotes Hutton for the purpose of showing that geology is not concerned "with questions as to the origin of things," and is entirely distinct from cosmogony and cosmogonic speculations.

The science of Geology is, indeed, like every other science, a knowledge of phenomena and their causes; and no period can therefore be considered geologic that is not represented by rock-masses on some part of the present surface of the globe. No doubt there were pre-Laurentian periods; but at present we know nothing of them, and they cannot yet be considered to come within the scope of geological inquiry. The objection which has frequently been made to the doctrine of uniformity, that it assumes the eternity of the globe, is therefore of no value, for geologists do not attempt to speculate on the causes of phenomena of which they have no kind of knowledge.

It is unnecessary to enter into any argument respecting the doctrine of uniformity, as it is now practically acknowledged on all hands; but we would observe, that an examination of geological literature will show that while the terms "convulsion," "catastrophe," and the like were in common use previous to the year 1830, since that time they have been used with a gradually decreasing frequency; and a careful study of the progress of geological thought will likewise show that this result is almost entirely attributable to the publication of Sir Charles Lyell's 'Principles of Geology.'

It has, however, been assumed by some geologists of the present day, that the only claim on our respect which it could be pretended that the 'Principles' possesses is founded on the supposition that the Idea of Uniformity originated with Sir Charles Lyell, and that as this supposition is incorrect, no special degree of merit should be attributed to Sir Charles for that particular work. Our own opinion is diametrically opposed to this, for according to our conception of the case the value of the 'Principles' lies chiefly in the proof it contains of Hutton's 'Theory of the Earth' being supported by positive evidence, instead of being a mere unsupported effort of the imagination. Sir Charles Lyell brought together in the 'Principles' a great mass of facts bearing on every phase of the theory, and this not in a mere superficial manner. Before the publication of this work, Hutton's Theory was to the great body of geologists nothing but the dream of an enthusiast; for ever afterwards it became a reality, and the theory of a philosopher.

The vexed questions of originality and priority are frequently the stumbling-blocks to a correct estimate of the services of great men. It has often happened that a great discovery has been made by one man, the importance and value of which have not been recognized until made manifest by another. The familiar case of the accidental discovery of Voltaic Electricity by Galvani, and the recognition of its importance by Volta, is an extreme instance; and the one under discussion, though differing from it in some essential respects (especially as regards accident), falls into the same category in others. Hutton, no doubt, was too far in advance of his age for his theory to be accepted by men of his generation, and it was characterized as premature by Dr. Whewell, even in 1837. How much longer it would have remained neglected had not Sir Charles Lyell written the 'Principles,' may to some extent be inferred by a reference to dates. Hutton's theory was first made public in 1788; from that time to the publication of the 'Principles of Geology' in 1830, a period of forty-two years, the progress made in Geological Dynamics is insignificant compared with the advance made during the thirty-six years which have since elapsed. We therefore endorse the opinion expressed by eminent men long ago, that Sir Charles Lyell's work was the beginning of a new era of progress in our science—the commencement, in fact, of a Rational Geology.

After scrutinizing the effects of existing causes of known intensity, as exhibited at the present day, Sir Charles Lyell was naturally led to examine the Tertiary deposits of different parts of Europe; and it was in tracing backwards the more and more complete disappearance of recent forms from Tertiary faunas that he conceived the idea of determining the relative age of these strata by the ratio which the recent species of Mollusca in their respective faunas bore to the extinct. Hence he proposed the now world-renowned classification of Tertiary deposits into Eocene, Miocene, and Pliocene; and enunciated the scheme for their determination commonly known as the "percentage test." The Eocene strata were defined as having only about one-thirtieth part of their Mollusca identical with living species, the Miocene as having about one-fifth, the Older Pliocene from one-third to one-half, and the Newer Pliocine nine-tenths.

The terms Eocene, Miocene, and Pliocene were at once adopted, together with the principle of classifying the Tertiary strata by means of the percentage of recent shells which they contain. But of late years several geologists and palæontologists have raised objections to the percentage test, as did Mr. Charlesworth when it was first proposed. It may not be out of place, therefore, to discuss the advantages that have accrued from its adoption during the last thirty years, and the probability of its eventually becoming superseded by some other mode of classification.

Sir Charles Lyell's classification depends on two principles; first, that the Mollusca are typical of the rest of the animal kingdom, and are, at the same time, the most convenient for the purpose; and secondly, that the percentage of recent species in a fauna varies inversely with its age. In the first place, it is certain that the fossils which are most generally and completely preserved belong to the class Mollusca. The shells of these animals are so durable, so easily recognized, and, generally speaking, so characteristic of the species to which they belong, that they form a much better medium of comparison than the remains of land-animals or of plants, which generally occur in a fragmentary condition, and the preservation of which is usually the result of some fortuitous circumstance. Again, other classes of marine organisms are either not so abundant in species and individuals, or they are not likely to be preserved in the fossil state. It is difficult to say whether the Mollusca are, or are not, typical, in their duration, of the rest of the animal kingdom. They are not so prone to change as higher organisms; but, on the other hand, species of shells do not, as a rule, exist through several geological periods, like species of Foraminifera. We should imagine, however, that while the scale furnished by each class of animals is true, each scale has a value of its own, which has a certain ratio to that of each of the rest. The scale furnished by the Mollusca being neither too large nor too small, is on this account preferable to several others; therefore, from every point of view the Mollusca seem more convenient for the purpose than any other group of organisms.

The proposition that the greater the age of a Tertiary fauna the smaller is the proportion of recent species that it contains, is extremely difficult either to prove or to disprove; but even if it can now be shown to be untrue, it was at the time the percentage test was proposed a most convenient fiction. Sir Charles Lyell urged that the recent faunas formed a common point of departure in all countries, and that in the event of Tertiary deposits being discovered in any region they could be referred, by means of the percentage of recent forms amongst their fossils, to their place in the Tertiary series. For many years this test has been applied with useful, even if but temporary, results; but it must also be admitted that in several cases the application has not been successful. We have Eocene and Miocene deposits in India, for instance; but the determination of the former depends almost entirely upon the fact of their containing a large number of species of Nummulites, and not upon any percentage calculation; while the reference of the latter to the Miocene division is wholly based on its Mammalian fauna. In Australia a very varied series of Tertiary deposits has been known for many years; but even the percentage test has not yet enabled Australian geologists to come to any agreement as to their Eocene, Miocene, or Pliocene date. One amateur geologist, indeed, appears to have been for years in a state of perpetual oscillation between the three.

In a series of papers Mr. Charlesworth stated thirty years ago* some of the objections which he then saw to the use of the percentage test; but although he alluded to other sources of error, he more especially dwelt on the disagreement existing between naturalists as to the amount of divergence necessary to constitute a species. To render this nugatory, he suggested an attempt to classify Tertiary strata by means of "the totality of the characters which each series exhibits," on the principle that there is a "uniform approximation to existing species, shown by the fossils of different deposits, corresponding to their respective antiquity."† But it is to be regretted that he did not himself construct the "table of degrees" which he proposed, nor illustrate his suggestion by making the attempt to classify Tertiary strata by means of it. The principle is no doubt correct, and has been used with signal success in the classification of plants into Natural Orders; it is also the one commonly used in classifying the older rocks, and ought not to be difficult of application to the Tertiary. The misfortune is that while many men possess a "destructive" faculty in an eminent degree, there are so few who, like Sir Charles Lyell, are gifted with a "constructive" genius. The former class of men do not benefit science, although they show that a scheme which works well is nevertheless faulty; but the latter are entitled to our gratitude for a system which, faulty though it may be, is infinitely better than none.‡

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* 'Mag. Nat. Hist.,' vol. ix., p. 537. 'Phil. Mag.,' 3rd ser., vol. vii., p. 81; vol. viii., p. 529; vol. x., p. 1.

† 'Phil. Mag.,' 3rd ser., vol. x., p. 8.

‡ "A maxim which it may be useful to recollect is this,—that hypotheses may often be of service to science, when they involve a certain portion of incompleteness, and even of error."—WHEWELL'S *Philosophy of the Inductive Sciences*, vol. ii., p. 225.

After all, changes in physical geography and in climate, in any given region, are the chief causes of uncertainty in the application of the percentage test. The climate of Europe, for instance, was much warmer during the Eocene and Miocene periods than it is now. As the climate became colder no doubt the animals and plants which inhabited Europe migrated to warmer regions. In Europe there are many deposits of the age of these warmer periods, and it does not seem unreasonable to believe that formations in more southern latitudes, containing fossilized members of the same fauna, would be more recent in date than the apparently contemporaneous strata in Europe. Indeed, if some members of a species become modified during such a struggle for existence, as takes place in a country whose climate is becoming unsuitable for its inhabitants, while stronger individuals retain their specific characters; and if the modified form does not survive, as a species, the one from which it descended, it is easy to see that a formation containing a larger proportion of extinct species may be more recent than one containing a smaller proportion, in a different latitude, or possessing in past times a different climate.

When the percentage test was proposed, the scientific world was not ripe for the consideration of matters so calculated to disturb the principles of geological chronology, and therefore Sir Charles Lyell's scheme passed almost unchallenged. That its adoption has been attended with beneficial results is quite certain, and until some better and equally simple scheme is proposed, it will no doubt continue to be the one most generally adopted. But it behoves every philosophical geologist to remember that increase of knowledge has rendered faulty that which at one time appeared to be perfect, "inasmuch as it had the appearance of possessing arithmetical accuracy."*

As science advances we are rather apt to forget that what to us are mere elementary, and apparently self-evident truths, were at one time original and great discoveries. So the services of our predecessors are not unfrequently too much underrated, and the truth of the old maxim that "familiarity breeds contempt" is proved in a new way. It seems, therefore, a good thing now and then to consider how large a debt we really do owe to those who have gone before us; often men who with imperfect aids have indicated the clue to some of nature's mysteries, which a more perfect knowledge of natural laws now enables us firmly to grasp. And if it should, as no doubt it frequently does, eventually become manifest that old ideas, interpretations, and theories are erroneous, there is not the less credit due to their authors; for have not their readings of nature for years answered all the requirements of a more perfect interpretation, and materially assisted science thereby?

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* 'Quart. Journ. Geol. Soc.,' vol. xxii., p. 230.

For instance, the Ptolemaic and Copernican systems of Astronomy were each supplanted in its turn; but does any astronomer pretend that their authors are therefore less worthy of a place in the very front rank of the great discoverers in his science? Therefore, although we admit that the percentage test is logically not faultless, we consider that Sir Charles Lyell is not the less entitled to great credit, and exalted rank as a geologist, for its promulgation more than thirty years ago.

As we have already stated, Sir Charles Lyell gave the names Eocene, Miocene, and Pliocene to his three great divisions of the Tertiary series; and he again subdivided the Pliocene into Older and Newer. As typical formations, he referred to the Eocene division the strata of the London and Paris Basins; to the Miocene, the Faluns of the Loire and the beds of the Superga, near Turin; to the Older Pliocene, the Crag of England and the Subapennine strata of Italy; and to the Newer Pliocene, the Sicilian beds and more recent deposits. He anticipated the future discovery of beds which would lessen the gaps that then existed between the members of these various subdivisions; and, it is almost needless to say, his anticipation has been amply realized. The question for us now to consider is how far these divisions are natural, and how far they are arbitrary. Many geologists would affirm that all divisions of strata are arbitrary, while others would contend for their being mostly natural. If the whole surface of the earth be considered, and if we are supposed to possess a complete knowledge of its geological history, then no doubt all divisions are arbitrary—for there must have been a continuous sequence of deposits. But in the present state of our knowledge—some deposits being unknown (either not explored or submerged) and others destroyed,—it is no doubt true that, for particular areas, while some divisions of strata are quite natural, others are more or less artificial. Now, into which category do these divisions of Eocene, Miocene, and Pliocene fall? Sir Charles Lyell himself would say that they are artificial, as all divisions necessarily must be. But for ourselves we should say that while these divisions are artificial, others may be, as far as Europe or any other region separately is concerned, as purely natural as any in the Geological scale.

A study of the literature of the Tertiary system will reveal the fact that in North Germany and in Austria, where certain portions of the series are extensively developed, geologists have been obliged to invent new terms to designate groups of beds which they have been unable to refer with confidence to any one of Sir Charles Lyell's divisions.

In North Germany, Professor Beyrich has grouped together, under his new term Oligocene, a long succession of beds older than the typical Miocene Faluns, and newer than the Nummulitic

(Middle Eocene) strata of the Paris Basin and other districts. Sir Charles Lyell, however, refers to his Lower Miocene all the beds as far down as the Hempstead series, including that deposit. The remaining strata in question he calls Upper Eocene. Sir Charles has confessed repeatedly that his line is purely arbitrary; but he contends that the other is equally so, and that there is consequently no need of a new term. Few Tertiary palæontologists will, we imagine, agree with him in this, and it certainly seems preferable to curtail the Eocene and Miocene, and interpolate a new group, than to be confessedly reduced to the necessity of drawing a line where there is no physical or palæontological break.

In the Vienna Basin there exists a very complete series of Miocene (Upper Miocene of Lyell) deposits, passing gradually upwards into newer strata. From the difficulty the Austrian geologists have experienced in defining the upper limit of the Miocene deposits, they have at last been led to abandon the terms Miocene and Pliocene, and to group the whole of the strata embraced within their definitions under the single term Neogene. In endeavours to assign to their place in the series the Tertiary deposits of other regions, questions have been raised as to the value of the distinction between Miocene and Pliocene strata, and some palæontologists have gone so far as to assert that the significance of the terms is far more climatal than chronological; in fact, that in tropical regions it is impossible to say that certain deposits are Miocene and not Pliocene, or *vice versâ*. Under these circumstances it certainly does seem advisable to unite the two divisions, especially for the purpose of assigning to their proper horizon the fossils of low latitudes. The revised classification would then exhibit to the old one of Sir Charles Lyell the relation shown in the following table:—

Lyell's Classification.	*German Classification.*
Pliocene Upper Miocene	Neogene.
Lower Miocene Upper Eocene	Oligocene.
Middle Eocene Lower Eocene	Eocene.

Even this revised classification cannot claim the merit of being entirely natural; but it is certainly nearer that Ultima Thule of systematists than the original one of Sir Charles Lyell. It would indeed be strange if geology had made no progress in this direction for more than thirty years; and the only marvel is that, in a science which makes such gigantic strides, the original classification has not by this time been entirely swept away. The fact that it has not, is, however, conclusive testimony of the reality and great value of the service to science which Sir Charles Lyell performed when he proposed it.

Closely connected with the general subject of existing causes, and forming a very important branch of the inquiry, are the phenomena connected with volcanic eruptions and the formation of cones and craters. Sir Charles Lyell has always taken a prominent part in the discussions which have from time to time arisen respecting certain of these phenomena, and more especially in the controversy between the partisans of the "crater of elevation" and "crater of eruption" theories. The old theory of the formation of volcanic cones was that a vent having been produced by the fracture of the earth's crust (which may have been attended with some degree of upheaval and dislocation), the volcanic materials subsequently ejected gradually formed a conical mound, having a depression in the centre. This mound, or "volcanic cone," is supposed to be composed chiefly of ashes and scoriæ, which have been ejected into the air, and on falling have naturally arranged themselves in the manner stated. The eruption of dykes and streams of solid lava from the newly formed crater assists in giving solidity to the cone, although it frequently destroys its symmetry by breaking down the walls of one side of the crater. This explanation has been termed the "crater of eruption" theory, and is the one which was most generally received until the celebrated Leopold von Buch propounded the opposing theory of "craters of elevation," an idea which was adopted by Humboldt, and therefore became generally received. Sir Charles Lyell and Mr. Poullett Scrope have always been consistent in their opposition to it; and it is, perhaps, entirely owing to their united exertions that it has now fallen so much into disrepute.

The "crater of elevation" theory may be thus stated:—A vent having been formed in the earth's crust, volcanic materials—lava, ashes, and scoriæ—are ejected and spread horizontally over the surface, the cone being subsequently formed by sudden inflation and upheaval from beneath.

Sir Charles Lyell devotes several pages in the 'Principles' to the refutation of this theory, and it may be as well to enumerate the chief points of his argument. In the first place, although upheaved strata of various ages occur all over the world, no single instance can be pointed out in which the upheaval has produced a form comparable to that of a truncated volcanic cone. Sir Charles Lyell therefore asks, "Are we then called upon to believe that whenever elastic fluids generated in the subterranean regions burst through horizontal strata, so as to upheave them in the peculiar manner before adverted to, they always select, as if from choice, those spots of comparatively insignificant area where a certain quantity of volcanic matter happens to lie, while they carefully avoid purely lacustrine and marine strata, although they often lie immediately contiguous?"* Secondly, it is in accordance with all analogy to expect that if these great volcanic cones were upheaved after the ejection of the matter composing them, their sides would be fractured and the volcanic strata shattered and disturbed in a considerable degree. But the reverse is the case, for of all isolated hills volcanic cones are the most symmetrical in form, and regular in the arrangement of their constituent materials.

Of late years it has been asserted that volcanoes could not have been formed by "eruption," because solid lava could not consolidate on a slope greater than three degrees, nor vesicular lava on a greater inclination than five degrees. But Sir Charles Lyell proved† that this is an error as to a matter of fact. He showed that several of the lavas of Etna of known date have formed continuous beds of compact stone on slopes of 15, 36, and 38 degrees, and in one instance (the lava of 1852) of 40 degrees. Other volcanic cones, such as the island of Palma, yielded similar evidence, so that this objection to the "eruption" theory has been fully answered. The objections to the "elevation" theory have not; they rest on a wider basis, so they probably never will. The form of a volcanic cone is, moreover, precisely that which would be produced by the falling of materials thrown vertically into the air from a central vent.

Sir Charles Lyell has naturally watched with great interest the recent discussions on subaerial phenomena, more especially those on the mode of formation of lake basins and on the origin of valleys and the denudation of the Weald. His latest published examination of these questions is contained in the sixth edition of his 'Elements of Geology,' but they will probably be more fully discussed in the forthcoming tenth edition of the 'Principles.'

In the first edition of the latter work Sir Charles Lyell taught that the Wealden area had been denuded by the sea, to which agent he also ascribed the formation of the chalk escarpments; but he referred the formation of the transverse valleys to the action of rivers running along lines of fracture. Professor Ramsay and others have recently contended that "rain and rivers" and other subaerial agents have produced all the surface-features, not only of the Wealden region, but also of the whole terrestrial surface of the globe, excepting of course volcanic cones and craters. In the opinion of the advocates of this theory the sea has planed off the surface of the land as it emerged, and this form has been termed by Professor Ramsay the "plane of marine denudation." All the existing physical features have been since produced by subaerial erosion. This theory appears to go as much too far in one direction as its ultra-antagonist, the theory of marine denudation, *pur et simple*, does in the other; and it is not surprising that Sir Charles Lyell should refuse to give his support to either. It is perfectly possible that atmospheric causes may have produced a greater effect in particular regions than even Sir Charles himself was able to prove in the 'Principles;' but that is quite a different issue, and merely a further proof of the doctrine of uniformity which he has advocated for so many years.

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* 'Principles,' first edit., vol. i., p. 387.

† 'Philosophical Transactions,' 1858.

It would occupy too much space to recount the arguments that may be urged in support of the different theories of erosion and denudation; but it may be remarked generally, that phenomena of so varied a character are not, as a rule, referable to the same cause. Certain valleys generally considered to have been scooped out by the sea may have been excavated by rain and rivers, or *vice versâ;* but a multitude of such instances, unless they embrace every possible character of valley and circumstance of occurrence, is not sufficient to warrant the general conclusion that *all* valleys have been formed by one agent, or by the other.

Another phase of the question is that respecting the meaning to be attached to the expression "form of the ground," this having been very recently the subject of discussion. If the very latest and smallest modifications of the surface are taken into account, of course the present "form of the ground" is due entirely to atmospheric agencies, *not* excepting volcanic cones and craters; but if this interpretation be insisted on,—why scientific discussion has degenerated into quibbling.

The theory of the formation of lake-basins by glacial erosion is fundamentally new, and has received from Sir Charles Lyell, in the last edition of the 'Elements,' and in a work to which we have not yet referred,* a fuller examination than the "subaerial denudation" hypothesis, which is merely an old notion revived in an overgrown shape. Sir Charles Lyell is no advocate of the theory that lake-basins have been scooped out by huge glaciers; and in the works we have mentioned he has fully stated the objections which appear to him to render it improbable. He admits, of course, that "heavy masses of ice creeping for ages over a surface of dry land . . . must often, by their grinding action, produce depressions in consequence of the different degrees of resistance offered by rocks of unequal hardness;" but the objections to any long continuance of this scooping action on any particular spot are the greater the larger and deeper the lake-basin to be accounted for, because to excavate such a depression a power is required "capable of acting with a considerable degree of uniformity on masses of varying powers of resistance." In opposition to the view that the great Swiss and Italian lake-basins were scooped out by glaciers Sir

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* 'Antiquity of Man,' p. 309.

Charles Lyell has brought forward several arguments, especially, (1) that "several of the great lakes are by no means in the position which they ought to have taken had they been scooped out by the pressure and onward motion of the extinct glaciers;" (2) that lakes of the first magnitude do not occur "in several areas where they ought to exist if the enormous glaciers which once occupied those spaces had possessed the deep excavating power ascribed to them;" (3) that the presence of patches of preglacial freshwater formations in some Alpine valleys, *e.g.* on the borders of the Lake of Zurich, prove that some of the lakes must have existed before the glacial period.

Sir Charles Lyell seems, however, in this instance, more fortunate in opposition than in proposition. He has shown that the "erosive power of ice was not required to produce lake-basins on a large scale," by means of the preglacial lacustrine formations of the Lake of Zurich. Some other cause must then have produced them if glaciers did not excavate them, and Sir Charles Lyell suggests "unequal movements of upheaval and subsidence." This theory ought to be capable of proof or refutation by geological surveyors, and no doubt it will sooner or later be submitted to the test; but until that is done little more can be said about it, than that it does not enlist in its favour the sympathies of those who have been trained by Sir Charles Lyell himself to the application of the doctrine of Uniformity.

The 'Antiquity of Man' was published as a *résumé* of the evidence which has recently been accumulated in favour of the contemporaneity of Man with certain extinct Mammalia. It was avowedly a compilation; but it contains a large mass of matter drawn from a variety of sources, and tending to strengthen the evidence in favour of Man having existed on the earth in Post-pliocene times. Perhaps not even the 'Principles' exhibits more clearly the author's wonderful faculty of "assimilation," as Dr. Fitton called it, of turning anything and everything into good geology. But it is unnecessary for us to discuss this subject at greater length, except incidentally, as being one of the last discoveries bearing on a view of the succession of life in time which Sir Charles Lyell has persistently maintained ever since the commencement of his distinguished career.

Negative evidence has always been a battle-ground for geologists holding opposite views, and it is only of late years that its use has fallen considerably in estimation. The experience of the last half-century has taught geologists that it is highly unphilosophical, and positively unsafe, to assume that any class of organisms has not existed at any particular period, or that there is a total break in the succession of life on the earth at any horizon in the geological scale, merely because we have no positive evidence in proof of the contrary. But Sir Charles Lyell can claim the merit of having foreseen the unstable nature of conclusions based on ignorance, for in the first edition of the 'Principles' he contended that the apparent breaks in the continuity of geological periods are due to our imperfect information, and do not really exist in nature; and also that the organic remains imbedded in known deposits do not represent the whole of the earth's inhabitants during those periods or in those regions; and he devoted some considerable space to the illustration of these views, in contrast with the then prevalent doctrine of catastrophes.*

In those days Lamarck's hypothesis of progressive development by transmutation of species excited a great deal of discussion; as also did the theory of the successive appearance on the earth's surface of more and more highly organized animals and plants. In support of the latter view, geologists appealed with alacrity to the fossils discovered in different deposits as affording a positive proof of its truth; and they thus endeavoured to define the order of nature, and to assign to each class of organisms the period of its birth. But Sir Charles Lyell contended† that at that time there was "no foundation in geological facts, for the popular theory of the successive development of the animal and vegetable world, from the simplest to the most perfect forms." And although subsequent discoveries have abundantly justified Sir Charles Lyell's protest against invoking negative evidence, to prove that this or that period witnessed the creation of such or such a class of organisms, he has at last admitted that the successive development theory is not much affected by successive discoveries, and is probably necessary in the present state of science.‡ It appears to us, however, not a little mischievous, in so far as it encourages an appeal to negative evidence, as was amusingly illustrated in 1851 by the late Professor Edward Forbes, in reference to the discovery of Pulmonifera in the Purbeck beds, "the (supposed) non-existence of which during the Secondary epoch has called forth not a few prematurely wise comments in geological works."

"Agassiz just had given his bail,
'Twas adverse to creation,
That there should live pulmoniferous snail,
Before the chalk formation."§

Since then Pulmonifera have been discovered in Carboniferous deposits, and the history of nearly every group of animals contains a record of similar premature conclusions and their subsequent refutation.

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* See also his Presidental Address to the Geological Society in 1851, ***passim***.

† 'Principles,' 1st edit., vol i., p. 153.

‡ 'Antiquity of Man,' p. 405.

§ Wilson and Geikie's 'Memoir of Edward Forbes,' p. 461.

Now to what conclusion does the sum of the evidence at present in our possession point? It cannot be denied that, as regards animals, the Protozoa are those of which we have the earliest evidence, in the *Eozoon Canadense* of the Laurentian rocks, if that primæval fossil be of organic origin. Whether the Coelenterata, Echinodermata, Mollusca, or Crustacea first appeared we have no evidence to show, as it is extremely improbable that the *Eozoon* was the solitary inhabitant of the seas during the Laurentian period. Known facts are in favour of the Annulosa appearing before either of the other great groups; whereas, according to the successive development theory, they ought to have appeared in the order in which they have been mentioned. But this evidence is purely negative, and therefore of little or no value. As regards the Vertebrata it is certain that we are cognizant of Fishes older than any Amphibia, and these again are older than any known Reptiles. The oldest true Reptile is probably Triassic, and thus older than either Birds or Mammals; but with regard to the order of appearance of these two classes, we meet with the same difficulty as before. Now the Vertebrata as a whole form a group of equal value with the Mollusca, Annulosa, &c., and should consequently be compared as a whole with the latter, not, as is usual, in four or five separate groups. From this point of view we should find that the present state of our knowledge lends very little countenance to the theory of uniform progression of animal life in time; and if we base our comparison on groups of smaller value the general result is much the same; for, as was shown by Professor Huxley, "if the known geological record is to be regarded as even any considerable fragment of the whole, it is inconceivable that any theory of a necessarily progressive development can stand, for the numerous families and orders cited afford no trace of such a process."* Nevertheless Sir Charles Lyell remarks, "It would be an easy task to multiply objections to the theory now under consideration; but from this I refrain, as I regard it not only as a useful, but rather, in the present state of science, as an indispensable hypothesis, and one which, though destined hereafter to undergo many and great modifications, will never be overthrown."†

This conviction was probably produced by the necessity which Sir Charles Lyell felt of abandoning his old opposition to the theory of the transmutation of species after carefully weighing Mr. Darwin's theory of Natural Selection. Sir Charles Lyell appears to think that there is a necessary and direct connection between these theories; but, on our part, we cannot see why a naturalist may not be an advocate for "descent with modification," and still refuse to accept the theory of *progressive* development. It is therefore rather surprising to read in the concluding sentences of Chapter XX. of the

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* 'Ann. Address Geol. Soc.,' 1862.

† 'Antiquity of Man,' p. 405.

'Antiquity of Man,' an attempt to account for the apparent paradox, "that writers who are most in favour of transmutation are nevertheless among those who are most cautious, and one would say timid, in their mode of espousing the doctrine of progression; while, on the other hand, the most zealous advocates of progression are oftener than not very vehement opponents of transmutation." Sir Charles endeavours to explain it by the belief of the former in the incompleteness of the geological record, and of the latter in its completeness; but it appears to us that there is a great deal more in the caution of the Darwinian than is dreamt of even in Sir Charles Lyell's philosophy.

So long as the doctrine of "transmutation of species" possessed only the old and crude form given to it by Lamarck, and so clearly illustrated by the author of the 'Vestiges,' Sir Charles Lyell attacked it with considerable vehemence. But a careful consideration of the theory of Natural Selection, and frequent conversations with Mr. Darwin on the subject, have had the effect we should have anticipated on the opinions of so thorough a master of the mode in which the causes of change operate. The principle involved in Mr. Darwin's hypothesis is one congenial to the mind of the author of the 'Principles.' A cause producing a small effect, which becomes greater and greater in the course of ages by successive repetitions, is one of all others most calculated to enlist the sympathies and charm the mind of the man who has for thirty-six years been endeavouring to establish the self-same idea in its application to inorganic nature. So we were not surprised to find Sir Charles Lyell, in the 'Antiquity of Man,' bringing to bear the vast and varied mass of information at his command in favour of the probability of the new doctrine. We were disappointed at not finding more light thrown on it from a geological point of view; but this defect will no doubt be remedied in the forthcoming edition of the 'Principles,' and is to a great extent compensated by some beautifully conceived arguments drawn from the analogy supplied by other fields of inquiry.

It is not now our intention to discuss the theory of descent with modification, that has very recently been done in this Journal;* but we shall examine two or three of Sir Charles Lyell's arguments in its favour, not so much on account of their illustrating the theory itself, as because they throw light on the nature of the predominating feature in the mental constitution of Sir Charles Lyell himself,—an object which we have had in view throughout this review of his labours.

Perhaps the most remarkable of these arguments is that drawn from the very clever comparison of a natural history species to a language, and consequently of Mr. Darwin's theory to the Aryan hypothesis. Considering that the 'Antiquity of Man' was written for the educated public, not specially for naturalists, it scarcely seems possible to conceive of a comparison better calculated to bring home to the understanding a proper appreciation of the aim and scope of the theory of "descent with modification." Professor Max Müller has observed, "That if we knew nothing of the existence of Latin, if all historical documents previous to the fifteenth century had been lost, if tradition even was silent as to the former existence of a Roman empire, a mere comparison of the Italian, Spanish, Portuguese, French, Wallachian, and Rhœtian dialects would enable us to say that at some time there must have been a language from which these six modern dialects derive their origin in common." Further, "Latin itself, as well as Greek, Sanskrit, Zend (or Bactrian), Lithuanian, old Sclavonic, Gothic, and Armenian are also eight varieties of one common and more ancient type, and . . . . have all such an amount of mutual resemblance, as to point to a more ancient language, the Aryan, which was to them what Latin was to the six Romance languages."* Now if we substitute for the names of these various languages the designations of allied species of animals or plants, having similar chronological relations, and if for the words "dialect" and "language" we substitute "species" and "variety," and so on, we have in these sentences a correct exposition of the doctrine of transmutation as applied to certain particular cases. The analogy is complete.

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* No. 10, April, 1866, pp. 151–176.

But this is not all: Sir Charles Lyell shows that the objections which would naturally be made by an illiterate person to the Aryan hypothesis are precisely parallel to those often made to Mr. Darwin's theory; *e. g.* "We all speak as our parents and grandparents spoke before us," &c. Then there is the same difficulty about the definitions of terms as in Natural History; for instance, "If this theory of indefinite modifiability be sound, what meaning can be attached to the term language, and what definition can be given of it so as to distinguish a language from a dialect?" We need not follow the comparison further; sufficient has been quoted to show the parallelism of the two cases, and the skill with which Sir Charles Lyell has brought into relief those points of the Aryan hypothesis which bear the most striking similarity to the theory of Mr. Darwin.

In conclusion, we must refer to Sir Charles Lyell's treatment of the charge of Darwinism being inconsistent with the existence of a Creator and the immortality of the soul. A reviewer asks, if there was a transition from the instinct of the brute to the noble mind of man, "at what point of his progressive improvement did Man acquire the spiritual part of his body, and become endowed with the awful attribute of immortality?"† Sir Charles Lyell appeals to "analogous enigmas in the constitution of the world around us;" for instance, the transitions between those "who are doomed to helpless imbecility" and the half-witted, "and from these again to individuals of perfect understanding." Again, "one-fourth of the human race die in early infancy, nearly one-tenth before they are a month old; so that we may safely affirm that millions perish on the earth in every century in the first few hours of their existence. To assign to such individuals their appropriate psychological place in the creation is one of the unprofitable themes on which theologians and metaphysicians have expended much ingenious speculation."

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* 'Antiquity of Man,' pp. 454, 455.

† 'Antiquity of Man,' p. 502.

Nothing can be more illogical than to reject a theory which explains much that was never explained before, because it creates a difficulty similar to that experienced in every department of human knowledge where the method of gradation can be applied. If Darwinism were to fall by such a blow, what scientific or theological system could stand? Sir Charles Lyell, therefore, accepts the philosophic dictum that "whatever is, is right," and he agrees with Dr. Asa Gray, as most assuredly do we, that "to do any work by an instrument must require, and therefore presuppose, the exertion rather of more than of less power, than to do it directly."*

In this review of Sir Charles Lyell's services to Geology we have omitted all notice of his numerous minor publications. We have endeavoured to select those of his works which exhibit his *difference* from the great mass of geologists; and we have neglected entirely those original essays which with him, as with everyone else, are simply the result of hard work and careful observation. Perhaps no geologist who has addressed himself so exclusively to the inorganic portion of the science has so much faith in the present value of palæontology, or so high an anticipation of its future destiny. His love of speculation is apparent in all his works, and was noticed by Dr. Fitton thirty years ago; but to whatever extent and in whatever direction Sir Charles Lyell may speculate in searching for the causes of phenomena, he never allows his speculative faculty to carry him beyond the bounds prescribed by analogy. Thus, all the hypothetical views which he has either propounded or advocated are based upon, or supported by, the analogy of similar phenomena in other departments of human knowledge, if nothing comparable with them is known in geology. Another test of the truth of any view, to which he frequently resorts, is what logicians call "antecedent probability," as is especially seen in his opposition to the theory of "craters of elevation."

Sir Charles Lyell, as we have sketched him, we consider to be the Founder of Modern Geology; not in the sense of usurping the laurels of Hutton, though much that Hutton believed was unsound, and what was philosophical was not generally received until Sir Charles Lyell proved its merit. Nor do we compare him with the great field-geologists; his mind is too restless in its hankering after the interpretation of ancient hieroglyphics to be satisfied with hoarding a mass of unread inscriptions. But we look upon him as the Founder of Modern Geology in the sense of his being the man who first clearly defined the principles of geological investigation, and who has lent additional lustre to his system by himself leading the way in the application of his precepts. The 'Principles of Geology' are now to his followers "familiar in their mouths as household words," and they look forward into the future for the 'Principles of Palæontology,' trusting that it may produce as great a revolution in the development of the offspring, as Sir Charles Lyell caused so long ago in that of the parent.

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* 'Natural Selection not inconsistent with Natural Theology,' p. 55.

II. ON THE IGNIGENOUS ROCKS NEAR MONTBRISON.

(With reference to the Antiquity of the Volcanos of Central France.)

By Charles Daubeny, M.D., F.R.S., Professor of Botany at the University of Oxford.

In the April number of the 'Quarterly Journal of Science' for 1866 will be found a memoir of mine, "On the Antiquity of the Volcanos of Auvergne," in which, in opposition to the late Sir Francis Palgrave and to certain divines who had followed in his footsteps and adopted his views, it was attempted to show, that even the latest of the eruptions proceeding from these mountains must date from a period antecedent both to history and tradition.

But as it must at the same time be conceded, on the testimony of two bishops whose writings have come down to us, namely Sidonius Apollinaris and Alcimus Avitus, that during the fourth century after Christ, certain physical commotions took place in the neighbourhood of Vienne in France, which were of a nature sufficiently formidable to suggest the offering up of public prayers, and even the institution of the Rogation-days, set apart ever since in the Church for divine worship, those who denied the recent date of the volcanic eruptions in that neighbourhood were called upon to show, that there are no vestiges of the kind round about the city of Vienne, which might by possibility be referred to a period comparatively so modern as the one alluded to.

I therefore pointed out in the above memoir, not only that, so far as is known, volcanos are entirely absent from the immediate vicinity of the city of Vienne, but also that the nearest indications of igneous action to be met with occur about Issoire, in the neighbouring department of the Puy-de-Dôme, a town situated in a straight line at a distance from Vienne of about eighty English miles, or else near Puy-en-Velay, which is not less than sixty from the same locality.

It has, however, since been suggested to me, that I had overlooked a little group of volcanos situated round about Montbrison, the capital of the department of the Loire, a town which lies considerably nearer to Vienne than either of the places to which my attention had been directed, being in fact not more in a straight line than about thirty-five miles distant from the city of Vienne, and that it was possible, therefore, that the convulsions of nature to which Sidonius and Alcimus refer might find their explanation in certain eruptions of which this neighbourhood had still retained the impress.

I was, therefore, glad to avail myself of the opportunity of visiting, in company with my friend, Mr. Corfield, a Fellow of Pembroke College, Oxford, the above locality on our way to Switzerland this autumn, and I am now prepared to say that, without pretending to have surveyed the entire district, I saw enough to convince me, that no volcanic disturbance which had occurred within this area at so late a period as that alluded to could have escaped our notice, and that every indication of igneous action which presents itself throughout the country bears marks of a much greater antiquity.

Thus much at least I can venture to affirm, namely, that neither craters, streams of lava, scoriæ, nor even cellular trap, are to be met with anywhere within the limits of this district. On the contrary, the only igneous rocks which came under our observation consisted of a compact basalt, containing nests of olivine, a material which could only have been elaborated by the aid of great pressure, and under a different configuration of the surface from that now existing.

To descend to particulars—the granitic formation, which occupies a large portion of central France, may be seen extending to the west of Montbrison, but the valley of the Loire, in which this town is itself situated, consists of tertiary fresh-water beds, covered over in many places by thick deposits of alluvial matter.

On the right bank of the Loire, however, the granite is again seen, and stretches as far as the Rhone valley, in which Lyons is situated.

Farther to the south, however, occurs the Coal formation of St. Etienne, which consequently intervenes between the valley of the Loire, in which Montbrison stands, and the city of Vienne, situated on the banks of the Rhone, which also is built upon a granitic rock.

Now both to the north and south of Montbrison, is descried, elevated above the general level of the granitic formation, a number of isolated knolls rising abruptly to a height of 500 feet or upwards, and in general capped by the ruins either of a church, a convent, or a castle, for which these summits would have been especially well adapted, both as being conspicuous objects from a distance, and also from their steepness being secure from assault.

We visited several of these little detached hills, as for instance, St. Romain-le-Puy to the south, and Marcilly-le-Pavé and Montverdun to the north of Montbrison, and found each of them composed up to its summit of basalt, which also extended nearly down to the level of the surrounding country.

At St. Romain-le-Puy, and Marcilly-le-Pavé, the trap rock rested upon granite, but that of Montverdun was incumbent directly upon the tertiary formation, which, as before stated, is superposed upon the granitic rocks on the lower levels.

Moreover, to the east of the road leading from Montverdun to Montbrison is a ridge, the longer axis of which lies nearly from north to south, wholly made up of the same material.

About half an English mile from Montbrison itself, at a place called " Le Roche," occurs the most instructive section which came under our notice; for here about halfway up the hill the basalt may be distinctly seen intruding itself into, and thrust through the midst of the granite, which is in consequence uplifted, and manifests itself both above and below the igneous rock, in the quarry, where the latter for road purposes is extensively worked.

Indeed the granite occupies a much more elevated position than this on the hills to the west of the spot where the basalt is seen, for the latter is found only at a certain elevation, being bounded both above and below by the granite of the country.

Judging from these facts, which are thoroughly borne out by the negative evidence, stated in the former part of this communication, I should conclude, that a vast antiquity must be assigned to the basalts which occur about Montbrison, for one can only account for the isolated position in which they are found on the detached knolls scattered over the district, by supposing that they constituted a part of one great continuous sheet of volcanic materials, which once overspread the surface, and of which the intervening portions have been since removed by denudation.

Of course such a supposition removes their origin to an immeasurable distance in point of time from any physical convulsions of recent or historical date, and indeed from the whole modern class of volcanos which has been described in my former memoirs on this country. They remind one of the basaltic eminences met with in Saxony, which Werner referred to his imaginary flœtz-trap formation, with reference to which we are also compelled to assume that the detached knolls of basalt scattered over the country, and resting upon the sandstone rocks which there predominate, are remnants of some great overflow of molten materials which covered the country, when the now elevated peaks constituted its lowest level, and when in all probability the entire district lay submerged under the ocean. We are therefore only obliged to transfer to Vulcan the task which the renowned geologist of Freyburg attributed to Neptune, and to conceive that a flood of melted matter discharged from his subterranean workshop overspread the district, instead of the deluge of water which, according to Werner, had risen to the summit of the highest hills, and which had left behind it on its retreat those flœtz-trap rocks which he insisted upon referring to an aqueous origin.

It would appear then, that the conclusion at which I arrived in my previous memoir is in no respect invalidated by anything observed at or about Montbrison, and that we are still at a loss for any facts tending to show, that the lively picture drawn by Sidonius "of the earthquakes which demolished the walls of Vienne, of the mountains opening and sending forth torrents of inflamed materials, and of the wild beasts driven from the woods by terror and hunger, retreating into and making great ravages within the towns," is to be regarded in any other light than as the offspring of a lively imagination, dwelling upon reports which had reached the author with respect to some fearful earthquake which may have occurred in the neighbourhood of Vienne.

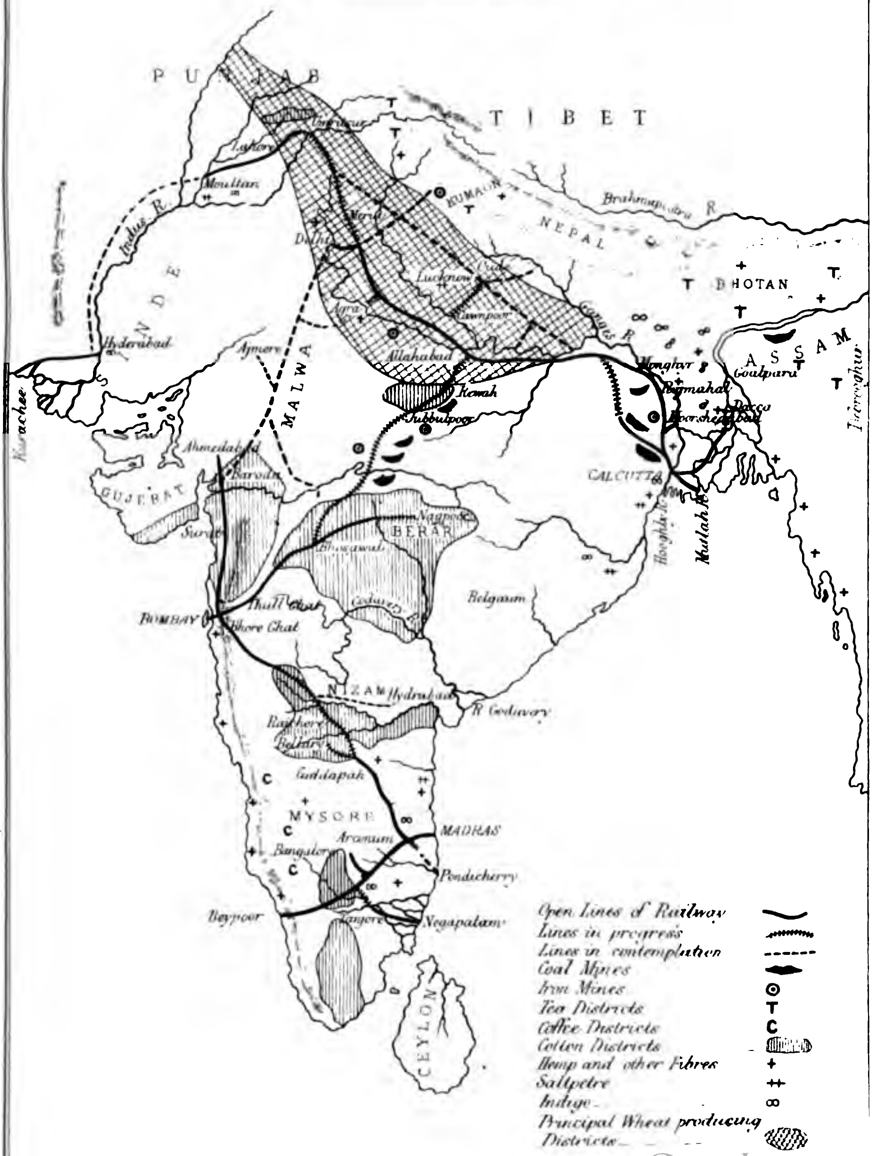
III. THE MEANS OF TRANSIT IN INDIA.

1. *Steam Navigation in British India.* By G. A. Prinsep, Esq., Calcutta, 1830.
2. *First Report of the Public Works Commissioners, Madras,* 1852.
3. *Statement showing the Number of Miles of new Roads or Navigable Canals opened for Traffic in each several Presidency of India, since the year* 1848. Printed Parliamentary Paper, No. 92 of 1859.
4. *Reports to the Secretary of State for India in Council on Railways in India for the years* 1859 *to* 1865–66, *inclusive.* By Juland Danvers, Esq.
5. *Statement of the Moral and Material Progress of India,* 1864–65. Printed Parliamentary Paper No. 374 of 1866.

When India first came into the possession of the East India Company there was scarcely, throughout the whole empire, one complete

OUTLINE MAP OF INDIA WITH RAILWAYS,

and the products of the Districts through which they pass.



road of any length on which it would have answered to employ wheel-carriages. There existed, however, proof that attention had once been given to the construction of roads, in the fine avenues of trees, which in some districts measured several hundred miles in length; but, as they had never been properly formed or drained, and bridges had not been built nor care taken to keep the pathways practicable, they were roads no longer. For some time after the establishment of British rule very little was done towards providing the country with roads, excepting where they were required for military purposes; the traffic of the country, however, profited in some degree by these military lines, and there can, even now, be traced in many of the great trunk roads the lines used for connecting the military arsenals and cantonments. With the year 1846 a new era commenced in the history of the roads of the country, and the operations and expenditure, being placed under the direction of a Road Department, began thenceforward to exhibit more satisfactory results; the introduction of the European form of wheel led, moreover, to the employment of cattle in draught where little or nothing had been done for the roads, and the improved condition of many hundred miles of road soon led to the extensive use of the common country-cart, or bullock-bandy, for the traffic between the inland districts and the coast.

The principal trade throughout the peninsula has, for many years, been carried on through the agency of a class of people called Bunjaras, who date the first establishment of their business prior to the Macedonean invasion in the fourteenth century. These Bunjaras are still extensively employed, but chiefly in the conveyance of coffee from the district of Wynaad to the Malabar coast, and in the conveyance of merchandize from the eastern coast into the interior. As the demand for improved means of transport throughout the country increased, the Government started a Banghy Dawk, for the conveyance of light articles, and a bullock-train for goods of a heavier nature, and passengers; and those establishments have since been superseded by the carts and waggons of the 'Inland Transit Company,' the 'Punjab and North-western Dawk Company,' the 'Indian Carrying Company,' and the 'Commercial Transport Association,' which undertake the conveyance of both passengers and goods.

The most expeditious mode of travelling by land was formerly by Dawk, in which the passenger rode in a palanquin borne on the shoulders of four men; the speed attained, however, was but slow, being only from three-and-a-half to four miles per hour, and the usual charge was one shilling per mile. Any other mode of travelling—especially when it was necessary to convey much baggage, or furniture—was excessively tedicus; anything of a delicate nature, such as glass, china, &c., was carried in bundles on the heads of men, and furniture was tied upon a charpoy, or bedstead, and carried by four men.

With few exceptions, little use was, in former times, made of the rivers of the country, and nothing seems ever to have been done to improve their navigation. In the heavy freshes, rafts of timber and circular boats of wicker-work covered with leather were floated down some of the larger streams, but on very few of the rivers was any attempt ever made to take laden vessels up the stream. Still less use was made of the canals of irrigation, though many of them were well adapted for water-carriage during six or eight months of the year. The backwaters of the eastern and western coasts were turned to somewhat more account, and a considerable traffic was carried on by means of coasting craft. In the districts of Bengal and the Punjab occurs the principal extent of river navigation in India, where, through the most populous part of the country, an area extending over about forty square degrees, and embracing the courses of the Ganges and Jumna on the west and south, the Brahmapootra and Megna on the east, was formerly almost entirely dependent upon water communication.

Attention seems to have been, at an early date, paid by the British Government to the improvement of communication through the backwaters on the western coast of India; but the first attempt to introduce canal navigation was by the formation of a channel to connect Madras with the Ennore backwater, and which now forms part of the East Coast Canal.

Soon after the conquest of Assam the difficulties in the navigation of the Brahmapootra, and the want of good communication by land with the upper parts of the valley, first suggested the expediency of applying steam to secure the desired facilities; and steam-vessels have ever since been successfully employed on many of the Indian rivers. In order the more effectually to organize the services of their river steamers the Bengal Government, in 1855, established an Inland Steam Department, their fleet at that time numbering five steamers, and five flats, which were employed on the rivers Ganges and Brahmapootra, between Calcutta and Allahabad and Assam. On the other side of India the Bombay Government also possessed an Indus Steam Flotilla, whose vessels plied regularly between Kurrachee and Mooltan, and they had also one steamer on the Euphrates; and in Pegu, six river steamers, with flats or troop vessels attached, kept up regular communication between Rangoon and all the stations on the river Irrawaddy. In subsequent years the different Government flotillas were gradually broken up, and the duty of providing for the river navigation of India was left open to private enterprise.

The steam companies at present existing, and by whose vessels the steam transport of India (both river and coasting traffic) is now carried on, are the following, *viz.* The Peninsular and Oriental Steam Navigation Company, with eighteen steam-vessels, and The Messageries Impériales, with fifteen vessels, afford communication with and between Calcutta, Madras, Pondicherry, Point de Galle, Bombay, Aden, the Straits settlements, and China. The British India Steam Navigation Company, with a fleet of twenty vessels, ranging from 350 to 1,500 tons burden, and 80 to 350 horse-power; the Bombay and Bengal Steam Ship Company, with eight steamers of from 850 to 1,473 tons; and the Bombay Coast and River Steam Navigation Company, with eleven steamers of from 131 to 750 tons, and 40 to 140 horse-power, furnish the means of communication between all the parts along the coast between Calcutta and Kurrachee, and with British Burmah. The India General Steam Navigation Company, with a fleet of nine river steamers of from 80 to 150 horse-power, and twenty-one flats of from 80 to 500 tons burden, send steamers regularly throughout the year, every seven or ten days, from Calcutta to the North-western Provinces, calling at all intermediate stations on the river Ganges; they also despatch steamers and flats periodically, in the direction of Dacca and Sylhet, to Cachar; and to Assam up the river Brahmapootra, once in six weeks, calling at all the intermediate places as far as Debrooghur. The Bengal River Steam Company, with four steamers of from 90 to 200 horse-power, and nine flats; and the River Steamer Company, with five steamers of 110 horse-power, and one of 130 horse-power, and eleven flats, navigate the Ganges as far as Allahabad, and the former company also despatches vessels up the Brahmapootra to Debrooghur. In addition to the foregoing there is Apcar and Company's line of six steamers which also navigate the rivers of Bengal.

On the western side of India there is the Indus Steam Flotilla Company, with eight steamers from 67 to 295 tons burden, and 90 to 200 horse-power, and two tugs of 67 tons and 40 horse-power, and two of 43 tons and 15 horse-power, navigating the river Indus between Kotree and Mooltan, the larger vessels being employed on the portion of the river above the Sukkur Pass, and the smaller steamers between that place and Kotree.

The subject of railway communications in India was first laid before the Supreme Government by Sir Macdonald Stephenson, in 1843, and in 1849 a contract was concluded with the East India Railway Company for the construction of an experimental line from Howrah to Raneegunge; and in the same year the Great Indian Peninsular Railway Company was incorporated, and entered into a contract for the construction of an experimental line from Bombay to Callian. Both these associations were formed in the year 1845, but the projectors found it impossible to raise the necessary funds for their proposed schemes without the assistance of Government;

it was therefore determined by the East India Company to guarantee, for a term of ninety-nine years, a certain rate of interest (five per cent. per annum) upon the capital subscribed for their respective undertakings, in addition to a free grant of all the land required for their railways and subsidiary works. As a rule all the Indian railroads are constructed, in the first instance, for a single line of railway, the bridges, tunnels, and cuttings being made suitable for a second line. The gauge in all cases is five feet six inches.

The works on the East Indian Railway were commenced in January, 1851; and in February, 1855, the whole line to Raneegunge, a distance of 121 miles, was completed. In the meantime, however, a general system of trunk railways for India had been determined upon, and the construction of a line from Calcutta to Agra and Delhi was conceded to the East Indian Railway Company.

Starting from Howrah, on the right bank of the Hooghly, opposite to Calcutta, this colossal line proceeds in a north-westerly direction to Burdwan, whence a branch to Raneegunge strikes off to the west through a district abounding in coal and other mineral resources, while the main line runs due north to Rajmahal, thus connecting Calcutta with the Ganges, and enabling traders to avoid the navigation of 250 miles of one of the most dangerous portions of the river. At Rajmahal the railway turns westward and follows the course of the Ganges, in some places touching its right bank, and in others running at a distance of seven or eight miles from it. Near Monghyr the line is driven through the only tunnel in its course, a length of 900 feet, through a hill of clay, slate, and hard quartz rock, and thence proceeds onwards to Patna, Benares, and Allahabad. Soon after leaving Patna, it is conveyed across the river Soane by a magnificent bridge, consisting of twenty-seven iron girders of 150 feet each, supported on brick foundations, and which, it is believed, is exceeded in magnitude by only one other in the world. At Allahabad the railway crosses the river Jumna by another very fine bridge, which was opened for traffic on the 15th August, 1865; it has fourteen spans of 205 feet each, the rails being laid upon the top of the girders, and the space beneath made available for an ordinary carriage road 11 feet in width. The line then takes a north-westerly course through Cawnpore, into the heart of the Upper Provinces, and at a point 20 miles from Agra (with which it is connected by a branch) it strikes northward, past Allyghur, to Ghazeeabad, where it meets the Punjab Railway, and whence a short junction line of 12 miles unites it with the City of Delhi.

The whole of this great undertaking has now been finished, and there is thus a continuous length of upwards of 1,000 miles opened for public traffic. In addition to the above, considerable progress has been made on a very important line of 225 miles, which, starting from Allahabad in a south-westerly direction, penetrates the cotton-growing districts of Jubbulpore, where it will join the Great Indian Peninsular Railway, and form the connecting link in the communication between Calcutta and Bombay. Moreover, the branch which was opened in 1855 to Raneegunge, and which has since been extended to Barrakur, is to be further carried over the Nargoonjoo Pass to Luckieserai, by which the distance between Calcutta and the north-west will be shortened by 71 miles; and a branch of 26 miles will at the same time be constructed to open up the Kurhurbalee coal-fields. The total length of the East Indian Railway with all its branches is about 1,500 miles, of which 1,127 have been opened. The line of rail is at present single throughout its course, except for the first 67 miles from Calcutta; but the cord line to Luckieserai will be made double, as will also the portion from thence to Allahabad.

The main object of the Great Indian Peninsular Railway is to establish means of communication between the three Presidency towns, and to connect the great cotton-growing districts of Central India with the seaport of Bombay. The line first commenced by this company starting from Bombay passed through the Island of Salsette and across the Tannah estuary to Callian, a distance of 33 miles, together with a short branch to Mahim, at the northern extremity of Bombay Island. The works were commenced in October, 1850, and finished in May, 1854. At the end of that year the company undertook the extension of their line into the interior, to unite with the East Indian and Madras Railways. At Callian, the line is divided into two great branches, the one going to the north-east, the other taking a south-easterly direction. The great physical difficulty in either case was to surmount the Ghauts, a lofty range which runs parallel to the sea along the whole west coast of the peninsula, and forms a barrier to the conveyance of the rich produce of the Deccan to the port of Bombay. The northern line is carried over the Thull Ghaut by an incline nine miles and a quarter in length, in the course of which it attains an elevation of 972 feet. It then proceeds by Nassick and Chalisgaum, to Bhosawul, at which point an important branch runs eastward through the great cotton district of Oomrawuttee to Nagpore. The main line, shortly after leaving Bhosawul, crosses the river Taptee, and continues its course to the north-east up the valley of the Nerbudda to Jubbulpore, where it meets the East Indian Railway. The southern of the two great branches is taken through the mountains at the Bhore Ghaut by an incline nearly sixteen miles in length, with a total elevation of 1831 feet, the difficulties of the course being overcome by such a series of cuttings, tunnels, viaducts, and embankments, as can hardly be rivalled in any other part of the world, except on the sister incline over the Thull Ghaut. The railroad is then continued to Poona, Sholapoor, and Kulburga, at which place it has been proposed that a line should branch off eastward to Hyderabad, the capital of the Nizam's territories, while the main line proceeds across the river Kistna to Raichore, where it forms a junction with the railway from Madras.

The distance from Bombay to Jubbulpore is 615 miles, that to Raichore, 441; and the operations of the company extend over a length, including branches, of 1,266 miles. It has been decided to construct the line double as far as Bhasawul, in the direction of Jubbulpore, and also to Lanowlie, at the top of the Bhore Ghaut incline.

The Madras Railway Company was established in the year 1852, with the view of constructing a railway from the city of Madras to the western coast. Operations were commenced in June, 1853, and on the 1st July, 1856, the first section, as far as Arcot, a distance of 65 miles, was opened to the public. In 1858, a further contract was entered into for a line towards the north-west, to meet the south-western branch of the Great Indian Peninsular Railway, and thus form a direct communication between the Presidency towns of Madras and Bombay.

The country through which the line to the western coast passes presented few obstacles to its progress, the only engineering difficulties being to convey the line across the several rivers which traverse its path. Leaving Arcot and Vellore a short distance on the left, and throwing out a branch on the right to the important military station of Bangalore, it turns southward through the Shevaroy hills to Salem, beyond which point it resumes a westerly direction, and, passing through the cotton fields of Coimbatore, finds its way by a break in the Ghauts, to the port of Beypoor on the coast of Malabar. The whole of this line from Madras to Beypoor, 406 miles in length, was opened for traffic in May, 1862, and on the 1st August, 1864, passengers were conveyed on the Bangalore branch, which is 86 miles long, and which attains a height of 3,000 feet on the Mysore table-land.

The north-west line, leaving the other at Arconum, 42 miles from Madras, proceeds through Cuddapah and across the river Pennar to Gooty near which point a branch strikes off on the left to the town of Bellary, while the main line crosses the Tongabuddra, and at Raichore joins the main line from Bombay. This portion of the railway is 338 miles in length; and as its path is crossed by twelve rivers, requiring upwards of three miles of bridging, and two ranges of hills, the works in some parts are very heavy. It has already been opened to Cuddapah, a distance of 119 miles, and it was expected that a further section of 32 miles would be ready by last Midsummer.

The Bombay, Baroda, and Central India Railway Company was formed to connect Bombay with the cotton districts of Guzerat and Central India. It was incorporated in July, 1855, and the cutting of the first sod took place in May, 1856. Starting northwards from Bombay, through the Island of Salsette, and crossing the Bassein Channel and the Veturnee River, the railway follows the line of the coast, passing Damaun and Surat, at which latter place it is carried over the Taptee River by an iron bridge of 2,003 feet in length. A still more serious obstacle to its progress presented itself in the river Nerbudda, which the railway crosses by another iron bridge 3,800 feet long. Continuing in a northerly direction it proceeds through Broach to Baroda, at which point it turns to the north-west over the Mhye river, and terminates its course at Ahmedabad, 310 miles from Bombay. The whole line is open, except a section of four miles within Bombay Island, from Grant Road to Colaba, which is to be conducted over land now in course of being reclaimed from the sea at Back Bay.

The Sind Railway Company was incorporated by an Act of Parliament passed on the 2nd July, 1855, and was reconstituted in August, 1857. Although its affairs are under a single board, the operations of the company in reality embrace four separate concerns; *viz.* the Sind Railway, the Indus Steam Flotilla (above described), the Punjab Railway, and the Delhi Railway. The object of the combined undertakings is to establish communication between the port of Kurrachee and the Punjab, and to connect the chief cities of that province with the East Indian Railway at Delhi.

The first portion, or Sind Railway proper, proceeds from the harbour of Kurrachee, across the rivers Bahrum and Mulleer, and through the Karatolla Hills, to Kotree on the Indus, opposite Hydrabad, and thereby enables traders to avoid the delay attendant on the navigation of the delta of the river. The length of the line is 109 miles; it was commenced in April, 1858, and was opened for traffic on the 11th May, 1861, with the immediate effect of developing a considerable trade in cotton, which had not been previously seen on the Indus, as well as in indigo, grain, wool, and other products.

The Punjab Railway, starting from Sher Shah on the banks of the Chenaub, about 12 miles below Mooltan, passes through that city, and thence follows a nearly straight course up the left bank of the Ravee, as far as Lahore, at which place it turns directly to the east, until it reaches Umritsur. This line, which is 253 miles long, was commenced in February, 1859, and on the 24th April, 1865, the complete line was opened to the public.

The Delhi Railway, running from Umritsur to Delhi, follows a south-easterly direction through the Punjab, and, crossing the Beas at Wuzeer Ghaut, proceeds by Jullunder to Phillour, at which place it is conveyed over the Sutlej. Continuing its course through Loodiana, Sirhind, and Umballa, it crosses the Jumna shortly before reaching Seharunpore, where it turns southward, and passing through Mozuffernugger and Meerut, arrives at Ghazeeabad, whence the trains will run into Delhi over the branch constructed by the East Indian Railway Company. The length of the whole line is 320 miles; the contractors commenced work in 1864; and although no portion has yet been opened, it was anticipated that the section between Ghazeeabad and Meerut would have been ready for traffic by the end of last year.

In 1857, the Eastern Bengal Railway Company was formed for the purpose of affording railway accommodation to the thickly populated districts lying north and east of Calcutta, which are richly cultivated with indigo, sugar, oilseeds, rice, and other grain. Starting from the Calcutta side of the Hooghly, it proceeds up the right bank of the Matabanga to Kooshtee on the Ganges opposite Pubna, thus enabling merchants to send their goods direct to or from Calcutta without undergoing the delay and danger of the navigation of the Soonderbuns. The works were commenced in April, 1859, and the line was opened through its entire length of 114 miles in November, 1862. Arrangements have been made for conveying passengers and goods by steamboats from Kooshtee to Dacca, and also to Assam. In August, 1865, it was determined to extend the line a distance of 45 miles to Goalundo, at the confluence of the Brahmapootra and the Ganges, with the view of intercepting the traffic from the countries on the north-east; and the railway company have agreed to construct it as a part of their original undertaking.

The necessity for increased accommodation for ships trading to Calcutta, and the dangers of navigating the Hooghly led to the formation, in 1857, of the Calcutta and South-eastern Railway Company, with the object of constructing a short line of 29 miles from Calcutta, in a south-easterly direction, to the harbour and town which it was contemplated to establish on the Mutlah estuary. The whole railway was opened for traffic in March, 1862, with the exception of the bridge over the Piallee, which was not finished till a later date; but it was not until the beginning of 1865 that a company was formed to build the necessary jetties and wharves required to make Canning Town a trading port.

The Great Southern of India Railway Company was constituted in 1857, its object being to construct railways in the southern provinces of India. The line at first sanctioned runs due west from Negapatam on the east coast, by Tanjore to Trichinopoly, through a country extensively cultivated with rice and cotton. Operations were commenced in May, 1859, and the whole line of 79 miles was thrown open for traffic in March, 1862. An extension of 87 miles was subsequently authorized to enable it to be taken through Caroor and up the right bank of the Cauvery, to join the Madras Railway at Errode.

The length of rail in course of construction by the eight companies above mentioned is 4,944 miles, of which 3,332 miles were in working order on the 31st March last. The capital estimated to be required for the completion of the several undertakings already sanctioned is 81,000,000*l.*, of which 60,645,000*l.* has already been expended. The traffic on the principal lines during the years 1865–66 exceeded the most sanguine expectations, and it is clear now that the traffic on them will be enormous, and that for some time to come it will increase in proportion to the means provided for carrying it. The passenger fares are low as compared with European rates, yet it appears that out of the total number of passengers carried, amounting to between thirteen and fourteen millions during the year, 94 per cent. travelled in the third, 4·78 in the second, and only 1·22 travelled in the first class. A sum of about eleven millions sterling has now been paid by the Government as guaranteed interest, over and above the amounts received from the earnings of the railways; and although it will be some time before so large an advance can be recouped, the condition of some of the railways gives reason to hope that, at any rate, a considerable portion will ultimately be repaid. Moreover, the free conveyance of the mails, and the reduction in the expense of transporting troops and stores, will effect a considerable saving, and the indirect gain to the State, arising from the greater security afforded to the country and the impulse given to commerce and agriculture, is incalculable.

Adverting to the probable early completion of the main lines of communication connecting the port of Bombay with the Presidencies of Calcutta and Madras, the North-western Provinces, and the Punjab, it was recommended by the recent select committee of the House of Commons on the subject of East India communications, that in future the mails for India should be conveyed to Bombay alone, and that the separate postal service between England and Madras and Calcutta should be discontinued. By this means a saving of several days would be effected in the communications between those places and this country.

In addition to the foregoing guaranteed railway companies, two companies, named respectively the Indian Branch Railway Company, and the Indian Tramway Company, have been formed for the purpose of constructing light lines of railway without the assistance of a preliminary guarantee from Government.

The Indian Branch Railway Company, in 1863, laid down a line, about 27 miles in length, with a gauge of 4 feet, from Nulhatte, a station on the East Indian Railway, 144 miles from

Calcutta, to Azimgunge, opposite to Moorshedabad; it was opened on the 21st December, and traffic carried on throughout the following year, though not to so great an extent as was anticipated. The same company has also obtained a concession of an important system of railway communication in Oude and Rohilcund, and considerable progress has been made on a section between Cawnpore and Lucknow, in which case the gauge of 5 feet 6 inches has been adopted, as on the main lines.

In the south of India a branch line has been constructed by the Indian Tramway Company, from the Arconum junction on the Madras Railway, to Conjeveram. This line, which is 19 miles in length, was opened on the 1st August, 1865; light rails have been employed, with a gauge of 3 feet 6 inches, and the total cost amounted to about 4,000*l.* a mile.

A few words, *en passant*, concerning telegraphic communication in India. In the early part of 1852, the working of an experimental line of electric telegraph between Calcutta and Kedgeree having proved entirely successful, it was determined to construct a complete system of telegraphic lines throughout India, and the aggregate extent of wire now in operation amounts to not less than about 14,000 miles. After an interruption of more than three years, British Burmah was, during 1864, once more connected with Calcutta by the construction of a land line through Arracan, in lieu of the deep-sea cable, which, after a short trial, utterly failed.

In 1858–59, schemes were proposed for establishing telegraphic communication between England and India, both by way of the Red Sea and the Persian Gulf. The line was laid, and messages were actually transmitted by the former route; but after a short period the signals failed, and all attempts to restore the communication for any length of time proved fruitless. Greater success has, however, attended the construction of the alternative, or Indo-European line, which, proceeding from Kurrachee in a westerly direction, along the Mekran coast by Gwadur to Bunder Abbas, and thence up the Persian Gulf to Bushire and Fao, at the head of the Gulf, has a total submarine course of nearly 1,500 miles; a land line has also been constructed as far as Gwadur. From Fao the line is conveyed overland to Bussora, and thence across Turkish Arabia to Bagdad, Mosul, and Diarbekir, whence it proceeds through Asia Minor, by Siras, till it joins the European system at Constantinople. The length of the whole line from Kurrachee to Constantinople is about 3,000 miles, one-half of which is submarine. From Bagdad another line has been taken through the heart of Persia to Teheran, and thence southwards to Ispahan, Shiraz, and Bushire.

With regard to the future, whatever may be said in favour of canal navigation in India, the experiments hitherto made in that direction have not been of so decidedly successful a character as to lead to the supposition that this means of transit will ever be very much extended. Where practicable, river navigation appears to be extensively used, and the success or otherwise of the works at present under construction with the view of opening up the navigation of the Godavery, will probably determine whether or not similar operations shall be carried out on other rivers. There is also no doubt that by the introduction of an improved class of steamers many rivers might successfully be navigated, which contain too small a depth of water for the majority of the vessels hitherto in use; three such steamers, calculated to draw only 12 inches of water, are now in course of construction for the river Godavery. Should they prove successful on that river, it is not unlikely that they will be followed by others on the same plan for employment on various streams hitherto not navigated by steam, and on which only vessels of very shallow draught could be employed. With respect to railways, it is not probable that any very great extension of the present system of high-cost lines will be sanctioned, except where they may appear necessary for political or military purposes, and we look rather to a development of the principle of light railways, which may readily be laid down along existing lines of road, and ultimately perhaps, when the traffic has become sufficient to justify the expense in a commercial sense, they might be completed substantially so as to unite with the existing system of high-speed railways, just as it is customary to make a fair-weather road in the first place, and afterwards complete it, by bridging and metalling, as a first-class road.

IV. ICE MARKS IN NORTH WALES.

(*With a Sketch of Glacial Theories and Controversies.*)

By Alfred R. Wallace, F.R.G.S., F.Z.S., &c.

One of the most interesting branches of modern geology, and that on which recent researches have thrown most light, is the inquiry into the exact modes by which the present surface of the earth has been produced. When we see a vertical precipice, a deep chasm, or huge masses of shattered rock, our first impression is to impute these effects to some violent convulsions of nature, such as volcanic eruptions, earthquakes, or floods. It is, however, now generally admitted that such causes have had, for the most part, little if any effect in modifying the surface, except when many times repeated during long periods of time; and it is every day becoming more certain that even the grandest and most romantic scenery of mountainous countries has been produced by the slow but long-continued action of those natural causes which we see daily at work, but whose effects during the few years that we can observe them are almost imperceptible. These causes are, the ocean waves, running water, rain and frost; which, if acting for long periods during which subterranean forces are also at work slowly elevating and depressing large tracts of country and to some extent fracturing and loosening the rocky strata, seem capable of producing all the chief features which the surface of the earth now presents in non-volcanic regions.

There are, however, a considerable number of very remarkable phenomena which none of these causes will account for, and which appear to have been overlooked or thought unimportant till about twenty-five years ago, when the celebrated naturalist Agassiz visited this country after having carefully studied the effects of modern glaciers in the Alps. He it was who first showed that they could be all explained to the minutest detail by the hypothesis of a recent "glacial period," during the continuance of which the mountains of Wales, Cumberland, and Scotland were covered with perpetual snow, and sent down glaciers into most of the valleys, and sometimes even into the sea. At first this hypothesis was received with incredulity and derision, since it completely contradicted the almost universal belief of scientific men that the earth had been for ages cooling, and that all preceding epochs had been warmer than the present one; but it very soon worked its way even among the most sceptical inquirers, till at the present day there cannot be found a geologist who denies the reality of the "glacial epoch," or the correctness of that interpretation which explains many peculiar features of our own mountain scenery by the agency of ice.

A great deal has since been written by geologists and physicists on the effects of ice-work, but comparatively little has been given to the general public; and as the subject is at this time again attracting much attention, owing to new applications of the theory which have given rise to much discussion and are greatly stimulating inquiry, and as it requires little or no previous knowledge of geology to understand either its facts or its theory, I have thought that a popular account of such prominent glacial phenomena as are observable in all our chief mountain districts would be acceptable to many readers of this periodical.

We may conveniently consider the chief evidences of a glacial period under the following heads: 1st, The drift; 2nd, Moraines; 3rd, 'Roches moutonnées'; 4th, Grooved and striated rocks; 5th, Boulders and perched blocks; 6th, Alpine lakes;—and in this order I propose to record the few observations I have made during a month spent near Snowdon and Cader Idris last autumn, incorporating briefly what has been observed elsewhere, and adding some account of the more interesting problems and discussions to which they have given rise.

1st. THE GLACIAL OR NORTHERN DRIFT.—This is a layer of loose materials—gravel, clay, mud, pebbles, and angular stones—which is found spread at intervals all over Northern Europe, and is very common in the valleys and upland slopes of North Wales. It is very abundant all round the town of Dolgelly, where it forms undulating slopes, mounds, and hummocks in most of the valleys, filling up the space between the flat alluvial meadows on the river side, and the steep rocky slopes of the adjacent mountains. Wherever this is cut through in making roads or railways, it is seen to be full of blocks of stone, pebbles, and large masses of rock, distributed through it without any order or arrangement, the top, middle, and bottom being alike in composition. From the contour of the surrounding mountains it can be often seen that this deposit is of great though very variable thickness, probably often exceeding a hundred feet, and it certainly covers many hundred square miles of country in North Wales alone. On ascending the mountains it is often found on their less precipitous slopes and in the upland valleys, at more than a thousand feet elevation; and it has even been traced around Snowdon by Professor Ramsay to a height of more than two thousand feet. The materials of which the drift is composed are various. Sometimes the rocks are nearly all those of the surrounding mountains, at other times they are such as must have been brought from a great distance. The geological age of the drift is determined by its overlying all, even the most recent formations, and by its containing occasionally marine shells of an arctic type and of species which are all now living.

Here we have materials of a loose and miscellaneous nature which were deposited *in* the sea but not *by* the sea. That the drift was deposited in the sea is proved by the marine shells which have been found in it up to the height of 1,300 feet on some mountains of Carnarvonshire; and we have thus a proof that North Wales was at a very recent epoch sunk to at least that depth beneath the ocean. The presence of the drift itself, however, at a height of more than 2,000 feet, would prove a much greater submergence. That the deposit could not have been made by the sea, is shown by the want of arrangement of the materials and the abundance of large angular fragments of rock. Water always sorts the materials it deposits. The rocks, the pebbles, the shingle, the sand, the mud, are carried different distances, and deposited in different places or in different layers. Water deposits are stratified. Neither can rocks be carried far by water and retain their angles and clean fractured surfaces. They get rounded into boulders or pebbles, whereas many of the rocks and stones found in the drift are as sharp, angular, and irregular as the blocks and masses which are detached by the winter's frost, and lie under an inland precipice.

The solution of this curious problem of the origin of the drift, is to be found in the history of glaciers and icebergs. When a valley is filled with ice, the rocky *débris* from its slopes and precipices fall upon the surface of the glacier. A quantity of the earth and stones of the bottom of the valley is also forced into the crevices or frozen to the bottom of the icy mass. Now when the ice-filled valley terminates in the sea, large fragments of the glacier break off and become icebergs, and floating away carry with them their load of earth and rocks, which are deposited where they melt, or topple over, or are stranded. In the North Atlantic as far as icebergs float, there must be an annual deposit of matter on its bottom exactly of the same nature as the drift, while in Hudson's Bay and the Gulf of St. Lawrence it must be accumulating still more rapidly. When North Wales was one or two thousand feet lower than at present, it must have formed a group of islands, among which icebergs would frequently become entangled and deposit their loads of foreign matter. At the same time Snowdon and Cader Idris would have been sending down glaciers into the sea, which would spread the *débris* of their precipices and valley bottoms on what are now the upland slopes and low valleys, but which then were submerged banks and ocean straits. As the land rose above the sea to its present elevation, rivers, floods, and glaciers would more or less furrow and clear away the drift from the valleys, and leave it distributed in the irregular manner in which we now find it. The mere presence, therefore, of this unstratified mass of earth, rocks, and boulders would of itself prove a recent glacial period; since it clearly indicates the existence of icebergs and glaciers in seas and countries where they are now never found.

2nd. MORAINES.—Every modern glacier carries upon its surface more or less of the *débris* of the rocky valleys through which it passes. As the glacier moves downwards, these are carried with it, and at its termination, where its waste by melting exactly balances its downward progress, this *débris* must necessarily be deposited, and form a more or less regular heap of rock and earth called the terminal moraine. These moraines are sometimes destroyed almost as fast as they are formed by the streams which issue from the glacier itself or by torrents from the adjacent mountains, but under favourable conditions they remain, and long after the glacier has entirely disappeared tell the tale of its former existence. If owing to a steady change of climate a glacier retires regularly, the moraine-heaps will be distributed over the whole surface its terminal ice-cliff has successively occupied; when on the other hand it is stationary for a considerable time, the *débris* accumulates to some height, and forms a well-defined terminal moraine. Some of the moraines formed by the old Swiss glaciers, when they stretched far down into the plains, are enormous. That of Ivrea in North Italy is many miles in extent, and 1,500 feet high—a mountain of *débris* brought down by a glacier which was sixty miles long. There is no other natural agent which can form on level ground such regular mounds as these moraines, many of which resemble artificial earthworks. Their presence becomes therefore a very certain indication of the former existence of glaciers.

In North Wales many very perfect moraines may be observed. Around Snowdon in particular they are very abundant, every one of the valleys which radiate from the central peak of the mountain exhibiting them more or less distinctly. These are all described in Professor Ramsay's little work on the Old Glaciers of Switzerland and North Wales; and I can bear witness that, far from exaggerating, he has hardly dwelt sufficiently on the wonderful clearness and well-marked character of this phenomenon. The most striking of all are perhaps those of the Cwm Glass Valley, which descends from the north of Snowdon to the pass of Llanberis. At the mouth of this valley, close above the road which ascends the pass, is what seems to the passer-by a steep rocky hill, but on viewing it from an elevation about a quarter of a mile lower down, it is seen to be a huge longitudinal roof-shaped mound of almost perfect regularity, scattered over with angular blocks of rock; and whose position, with regard to the sides and bottom of the valley, shows it to be an addition—something put there—and having no relation to the proper contours of the surface. Higher up the valley is a small but wonderfully perfect moraine, which stretches across in a regular curve, and of almost uniform size and height, so that when standing on it one can hardly help believing it to be an artificial fortification. But the huge angular blocks of rocks scattered about it, and the other signs of ice-work all around, with the wild loneliness of the situation, and its inferiority as a defensive position to many other points near it, utterly forbid this supposition. The best example of the wide-spreading of rocky *débris* by the gradual retreat of a glacier, is to be seen in Cwm Brwynog. Under one of the blackest precipices of Snowdon lies the little green lake Llyn dur Arddu, on the other side of which rises a steep ridge, most likely partly rock and partly moraine. Beyond this ridge extends for nearly a mile a gradually-sloping upland, so thickly covered with blocks of rock, often of large size, that from a distance the herbage can rarely be seen between them. In this case every one of these rocks must have been carried across the valley of the lake and deposited where it now lies, and no other natural agent can be found or imagined capable of doing this but ice. Lower down this same valley, on the spur which separates it from Llyn dwythwch, are portions of moraines deposited by the glacier when, during its greatest extension, it descended to join that of the vale of Llanberis. The moraines around Cader Idris are not so numerous nor so well marked as those of Snowdon. There is, however, a very fine one circling round Llyn y gader, under the highest peak; and lower down, below Llyn y Gafer, is a rock-strewn slope, even more thickly covered than that of Cwn Brwynog. Llyn Cai, situated in the tremendous chasm on the south of Cader Idris, has also a small but very perfect moraine at its extremity, through an opening in which its waters escape. I believe that the existence of moraines and moraine matter, when as well marked as those of North Wales, is of itself sufficient to prove that there has been a glacial period. There is, however, much other confirmatory evidence.

3rd. Roches Moutonnées.—Glaciers are often many hundred or even several thousand feet thick, and as they move slowly over the surface their enormous weight, assisted by the gravel, pebbles, and boulders frozen or imbedded in them, grinds down all sharp angles, peaks, and jagged edges of the rocks, giving to them a more or less blunted or rounded outline. The degree to which this grinding away takes place must depend on many causes, such as the weight of the glacier, its rate of motion, the material it carries with it, the time it continues in action, and the hardness, toughness, and original form of the rock itself. This peculiar effect of the passage of a glacier is very easily recognized when once seen, especially if one studies the forms that the rock assumes by natural weathering or by the action of water, both of which will be seen to be very different from that produced by ice. In the valleys around Snowdon and Cader Idris this form of rock-surface is continually to be seen, and when, as is frequently the case, the comparatively soft, slaty rocks can be compared side by side with hard greenstone or grit, the first is found to be ground down to a smooth surface, gently curved or rounded, while the second is left in irregular bosses and lumps, all their asperities smoothed and rounded off, but not ground down to an even surface. This can be well seen on the banks of Llyn Padarn, near Llanberis. It is upon these *roches moutonnées* that are often found the peculiar markings we have next to consider.

4th. Grooved and Striated Rocks.—During the process just described, it frequently happens that grooves or scratches are made upon the rocks by the hard materials imbedded in the bottom or sides of the glacier. Owing to the enormous weight and slow motion of glaciers, they move with great steadiness, and thus the markings on rock-surfaces are almost straight lines parallel to each other, and show the direction in which the glacier moved. Nothing is more striking than to trace for the first time over miles of country these mysterious lines, ruled upon the hardest rocks, and always pointing in the same direction. In the neighbourhood of Llanberis they are so abundant, that it seems strange they were not observed, compared, and speculated on long before their true nature was known. The lines vary from fine scratches to grooves in which one's finger may lie, and even to troughs a foot or more in diameter. Sometimes on very hard rock the grooves are polished by the intense pressure of a hard smooth pebble. On the east side of Llyn y gader is an even slope of near a thousand feet at an angle of about 45° called the Fox's Path, and covered with loose fragments of rock which roll away under one's feet at every step. It descends from a saddle between two eminences of Cader Idris, and was probably long the path of avalanches or small glaciers. In the bed of a torrent which descends this slope I found, recently exposed, a large piece of yellowish porphyry, one surface of which (about 5 in. by 3 in.) was slightly ridged and furrowed, and highly polished. The rock is very heavy and excessively hard, and this fragment is of itself a striking proof both of the presence of ice and of its power as a grinding and polishing agent. I presume that the piece formed part of the rocky bed over which the ice once slid, that it had been split and loosened by atmospheric action and then covered up and preserved by sediment and stones, till the torrent exposed it again, and would soon have destroyed its polished surface had I not been lucky enough to hit upon it.

But it is not only the surface of rocks *in situ* that are thus marked. The pebbles, boulders, and fragments embedded in the glacier are themselves equally scratched, but as they are capable of shifting their position the grooves and striæ on them are not always parallel to each other. It is this kind of material that contributes largely to form the drift, and in some localities almost every boulder and pebble is more or less marked. On close examination we can often find proof that the grooves are really ancient markings by their correspondence in appearance with old surfaces of the stone, although this is sufficiently evident to anyone who sees their number, and the variety of rude masses which bear them. These various classes of markings are all found abundantly wherever glaciers now exist, and as no other mode of explaining their occurrence has ever been suggested, they may be considered to form the best and most convincing of all the various proofs of the former existence of glaciers and icebergs in places where they are not now found.

5th. BOULDERS AND PERCHED BLOCKS.—As a glacier in its passage down a valley covers many irregularities of ground, sometimes passing over lateral spurs or rocky eminences, so during its retreat the ice-cliff which terminates it will pass over each of these in succession, and will deposit on many of them some of the blocks which form its moraines or the boulders it has brought down with it. When the glacier has finally retreated, many of these blocks and boulders will remain in positions where neither simple gravitation nor the action of floods of water, nor the shocks of earthquakes could have placed them. Very similar phenomena have been produced by the icebergs which deposited the drift, large masses of rock having been carried and dropped on eminences as well as in valleys. Not unfrequently these blocks rest upon rock of a different kind from that of which they are themselves composed, and they often rest on ice-worn surfaces marked by grooves and scratches, showing plainly that the face of the country has undergone little or no change since the ice left it. Many of them occur on the edge of precipices and ravines, as is particularly the case at the torrent walk near Dolgelly, the sides of which on nearly level ground are thickly strewn with large angular blocks and boulders. One of these is 15 feet square and 9 feet high, and has lower ground all around it. It is when they stand upon the summit of conspicuous eminences, as they often do about Snowdon and Cader Idris, that they attract most attention, while when thickly strewn over level ground or on slight hillocks and ridges they are passed over by the tourist as too common a phenomenon of mountainous countries to deserve attention. Yet it is really as difficult to account for their presence in the one case as in the other, without the agency of ice. Neither do they form a universal feature of mountainous regions, as many suppose, for, as far as my memory serves me, they do not occur on mountains of moderate heights in the tropics. I have ascended many mountains in the Malayan Archipelago about the same height as Snowdon, and on calling to mind all the places where large blocks of rock were scattered about, I cannot remember any that were not at the foot of steep declivities to which they might easily have rolled. I much regret that I was not then aware of the importance of minute observations of the kind. It appears certain, however, that in hot countries and where there is no reason to believe that glaciers have ever existed, this phenomenon of the wide distribution of angular blocks of rock over slight slopes, level ground, and eminences, does not occur, otherwise it would have been brought forward long ago, as a complete disproof of the glacial hypothesis. In South America, however, I did meet with one remarkable perched block, a tabular mass from 20 to 30 feet in diameter supported on two points of rock only, and as far as I can recollect situated on a slight eminence, certainly not under a steep slope from which it could have fallen. Its position was exactly such as might be produced if it had been deposited by a grounded iceberg, but hardly by any other means.

It was about half-a-mile from an isolated granite mountain in lat. 0° 30′ N., long. 68° 50′ W.*

This observation becomes of considerable importance now that Professor Agassiz tells us that he has found plain traces of glacial action in the valley of the Amazon. That glaciers have ever descended from the Andes to the Atlantic ocean, a distance of more than 2,000 miles, will hardly be credited except on such overwhelming evidence as even Professor Agassiz does not pretend exists. There are not, however, the same difficulties in the way of the supposition that icebergs once floated over what is now the great Amazonian plain. A depression of 1,000 feet would sink the whole of that plain deep under the ocean, and that such a depression has occurred is rendered probable by the great extent and almost perfect level of its alluvial deposits. Neither is it unreasonable to suppose that during the glacial epoch of Europe and North America the temperature of South America was so much lowered as to bring the line of perpetual snow down to 12,000 or 13,000 feet. This would cause a wide extent of the plateaux in South Peru and Bolivia to become the feeders of glaciers, which might have been as much larger than those of the Alps, as the comparative height and extent of the two mountain systems would lead us to expect. Such glaciers descending the highly inclined Andean valleys would move with proportionate rapidity, and might not improbably reach down into an almost tropical climate and send off rock-laden icebergs into the warm inland sea that then washed the base of the Andes. This, however, is quite a digression from our present subject.

On the very summit of Cader Idris there are several detached eminences formed of large square and polygonal blocks, which in some places stream down the slopes of the undulating surface of the mountain top. Were they lower down we should at once pronounce them to be moraines, but in their present position they are somewhat difficult to account for. I think, however, there can be little doubt but that they are due to the action of the snow and frost during the last portion of the glacial period. As soon as the perpetual snow line reached the top of the mountain, and the permanent glaciers below had all melted away, there must have been a long period during which the rocks on the summit were subjected to the alternate action of ice, snow, and water. During the winter they would be buried under many feet of snow, which would be forced into every crevice in the form of compact ice. During the short summer the snow would melt from the surface, but the water in the fissures would be probably frozen every night, leading to the further fracture and displacement of the rocks. The pressure of the snow and ice in the succeeding winter would force these always a little downward in the direction of least resistance, and this alternate action, combined with the character of the rock, which is here chiefly basaltic and splits into rude tabular and columnar masses, seems sufficient to have produced that mass of blocks heaped confusedly on the very summit of the mountain, which almost always suggests to the mind of the non-geological visitor some tremendous convulsion of nature, and makes him readily accept the popular theory that the vast hollow of Llyn Cai is a volcanic crater.

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* See Wallace's 'Tavels in the Amazon and Rio Negro,' p. 219.

In the 'Geological Magazine' for September, 1866, Mr. Macintosh maintains that the action of the sea has had most to do with the formation of the valleys, cwms, and rocky surfaces of the Welsh mountains; and he particularly instances Mynydd y Gader, a rounded rocky mountain between Cader Idris and the town of Dolgelly, as offering unmistakable evidence of a "seaworn summit." I therefore devoted an afternoon to an examination of this mountain, and was much surprised to find all over it what appeared to me the most unmistakable evidences of "ice-work." The mountain is composed of greenstone and lower Silurian flags, with veins and masses of quartz. It is very rugged and uneven, consisting of rounded lumps and knolls with numberless hollows and little valleys between them. These are all more or less thickly covered with angular blocks, slabs, and columnar masses, some standing on the very summits of the knolls, others lying on steep slopes; but there is no arrangement of them in lines or layers, there are no water-worn pebbles or boulders, no sand or shingle, nor, as far as I could see, any sign whatever of the action of the sea. On the other hand, the whole mountain offered the finest possible examples of *roches moutonnées*, the smooth slopes always facing Cader Idris, from which the glacier had come. Some of these ice-ground surfaces were as smooth as a pavement although formed on the outcropping edges of the hard Silurian rocks, an effect which the sea *never* produces. There is an angular block containing about twenty cubic yards of stone, standing on the slope of one of the highest bosses of the mountain, with no precipice from which it could have come nearer than Cader Idris, more than a mile off, with a valley between. Owing to the exposed situation of the *roches moutonnées*, their surfaces have been much weathered, and I did not succeed in finding good groovings or scratches, though I have no doubt such could be found by a more careful search. With this exception, the evidences of recent glacial action are seldom to be seen more plainly than upon this mountain.

The phenomena of existing glaciers and icebergs have been now so carefully studied, and the various effects which they produce are for the most part so well known, that there is no longer any difference of opinion among geologists about referring such phenomena as I have hitherto been considering to the action of ice, even though the countries where they occur no longer produce glaciers. But on the question of the origin of Alpine Lakes, which we have now to consider, there is no such unanimity.

6th. ALPINE LAKES.—It is only about five years since Professor Ramsay propounded the startling theory that almost all the lakes which form one of the greatest charms of our mountain districts, were actually produced by that comparatively recent irruption of thick-ribbed ice over a great part of the temperate zone, which we can hardly contemplate without a thrill of horror; and that during the preceding warm tertiary epochs they were so scarce as to form no important feature in the scenery of Europe. A short and simple statement of this theory is as follows. In all districts where glaciers have been proved to exist there are numerous lakes. In exactly similar districts where there is no trace of there having ever been glaciers, there are few or no lakes. This holds good all over the globe. Glaciers wear away their beds, as proved,—first, by the immense quantity of sediment in all glacial streams; secondly, by the existence of "roches moutonnées" whereever glaciers have passed. It can almost always be shown that the old glaciers have passed over the exact spots where the lakes now are, and the size of the lakes bears a general proportion to the proved size of the old glaciers. This theory of the glacial origin of Alpine lakes is now the great battle-ground of physical geologists. In this country Ramsay, Jukes, Geikie, and Tyndall are its chief supporters; Sir Roderick Murchison and Sir Charles Lyell, its chief opponents. Every year brings fresh evidence and new combatants; and as it is a question of such great interest, and at the same time one rather of physical than of purely geological science, I shall endeavour to give such an outline of the subject as may enable the general reader to understand the question at issue and form his own judgment upon it.

The first point to be considered in explaining the origin of lakes, is to form such a theory as shall not only show how such and such particular lakes were or might have been formed, but shall also account for their present actual distribution over the surface of the earth. This may be learnt from good maps as well as by personal observation, and is highly peculiar. In our own island we all know that it is only in three mountainous districts that lakes abound; in Wales, in Scotland, and in Cumberland. The lakes of these districts amount to some hundreds. In Europe the best known lake district is that of the Alps, which contains hundreds of lakes and many of very large size. In the Scandinavian peninsula lakes are still more numerous, abounding not only in the mountain valleys but also out in the low flat country, which, as well as all Finland and wide districts of North Russia, are literally studded with thousands of lakes. In North America, while the middle and Southern United States have scarcely any lakes, all the North-eastern States, Canada, Nova Scotia, Labrador, and in fact all the northern part of the continent, although much of it is level ground, is absolutely strewn broadcast with lakes, which must number very many thousands of every size, from the great inland seas like Lake Superior down to small tarns and ponds. In British Columbia, Oregon, and North California there are also abundance of lakes. In the great plateau of Asia there are lakes in plenty in Mongolia, in Tartary, and in Thibet, and all along the northern side of the Himalayas. But on going south from all these countries, the lakes in most cases abruptly cease. On carefully examining the best maps of Spain, a country of immense extent and highly diversified both geographically and geologically, I can find not a lake marked upon them. The fine island of Sardinia contains groups of mountains rising to 3,000 and 6,000 feet high. It has a varied geology, presenting abundance of granitic, metamorphic, tertiary, and volcanic rocks, and yet, according to a large Italian Government map, it contains not a single mountain lake. The Atlas range of mountains in North Africa presents us with no lakes. In America, the great West India Islands, Cuba, Jamaica, and Haiti, appear to have no lakes. Further south, the immense empire of Brazil, with its vast mountain ranges, its plains, savannas, and innumerable rivers, is almost destitute of lakes, except a few small ones near the sources of some of its southern rivers. In Asia the immense peninsula of India and the fine island of Ceylon seem to have hardly a true inland lake. In Africa, the Cape district and Natal have plenty of mountains but no lakes. Central, Africa, it is true, has lakes, few in number but of large size. They are not, however, accompanied by the immense number of smaller ones which occur in every one of the before-mentioned "lake-districts," and probably come under a distinct category, as lakes formed by unequal subsidence and upheaval. Australia possesses a few lakes; Van Diemen's Land, several; while in New Zealand they abound, especially in the southern districts where large glaciers still exist, and where there is a true lake-district very similar to that of the European Alps.

Now here we have a most remarkable fact,—*the fact* which must be considered in dealing with this question,—namely, that in all countries and districts of the globe where the universally-admitted evidence of extensive glacial action exists, lakes abound, and form one of the great features of the country; while wherever there are no signs of ancient glaciers, or no reason to believe that the country has in recent geological times been subjected to the action of ice, these lakes are either very few, or (much more frequently) entirely absent. So vast is the disproportion, that if we leave out such lakes as are near the sea-coast, or in alluvial plains where they may have been easily formed by changes in the course of rivers, and such as in volcanic countries are formed in the craters of old volcanos, it is probable that for every *thousand* lakes that exist in glaciated districts, not *one* can be counted in all the rest of the globe! There is, therefore, a strong *primâ facie* case in favour of a theory which directly connects glaciers and lakes as cause and effect; and the opponents of that theory, if they cannot absolutely prove it to be false in a good many cases, should be prepared with some plausible hypothesis which will equally well explain this prominent fact. Yet, strange to say, I have been unable to find that any such hypothesis has been yet put forth. Professor Ramsay's opponents all confine themselves to pointing out the difficulties of his theory in particular cases. They say that ice cannot travel up a long slope from a depth of more than 2,000 feet; that it would remain immovable at such depths, the upper layers sliding over the lower; that a glacier's power of erosion is very slight; that the ends of some existing glaciers are seen to rest on loose moraine matter without even disturbing it; and other arguments of a similar nature.* These arguments may be good or bad, and Professor Ramsay has answered them all himself in the 'Philosophical Magazine.' What I particularly wish to call attention to is the fact, that the only theory put forward even by the most eminent of his opponents is, that the depressions in which lakes lie (when they are bounded by rocky strata and not merely dammed up by moraines) have been formed by unequal disturbances of the crust of the earth or upheavals of valley bottoms, and that the ice during the glacial period may have filled up and slightly modified these basins, and also have prevented them from being silted up, but did not form them. In no one case that I am aware of has it been shown that the strata are thus tilted in opposite directions so as to produce a lake basin, nor is any hint given why these tiltings and depressions should have occurred in the proportion of a thousand times in glaciated districts to once in countries that have not been ice-ground.

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* It appears to have escaped the notice, both of Professor Ramsay and of his opponents, that in the paper which immediatey precedes that on the "Glacial Origin of Lakes" in the Geological Society's Journal of August 1st, 1862, Mr. Jamieson adduces evidence of the very fact which has so repeatedly been denied in reference to Professor Ramsay's theory, namely, *that a glacier can move bodily for a considerable distance up a slope*. Mr. Jamieson states, that from the point where the gorge below Loch Trieg opens into Glen Spean, all the ice-marks indicate that the glacier had parted in two directions, flowing both down the valley to the west, and *up the valley to the east*, along Loch Laggan and over the pass of Makoul into the valley of the Spey. This is proved by the lower side of the rocks being abraded and smoothed above the entrance to Loch Treig, while lower down it is the upper sides that are ice-worn. In Glen Roy also the same thing has occurred, the glacier having moved up it instead of down it, and discharged itself over the water-shed into another valley instead of by what now appears its natural outlet into Glen Spean. A sufficient cause for this extraordinary phenomenon seems to be found in the former immense accumulation of ice in Glen Spean, rising far up above both these low passes, as proved by plain ice-marks to the height of more than 2,000 feet. It would be very important to have an accurate survey made of this district, with all the heights well determined, and a thorough examination of the glacial phenomena it presents. These, as described by Mr. Jamieson, clearly indicate that in two separate cases glaciers about twelve miles long have been forced to move up hill, and to empty themselves over the passes at the heads of their respective valleys; and that in so doing they have abraded the rocks at the sides and bottoms of the valleys, showing that the ice could not have remained stationary below while it was flowing on above.

The suggestion that lakes, however numerous, formed beyond the limits of the ancient glaciers, may have been all silted up and converted into alluvial plains while those filled by ice have alone been preserved, seems at first sight to meet the case, but a little consideration shows that it is quite inadequate to solve the problem. First, we have no right to start with any other assumption than that lakes before the commencement of the glacial period were distributed with some average regularity over the different regions of the globe, if causes so universal as tiltings and depressions of strata were the chief causes that produced them. Secondly, if the present disproportion in the distribution of lakes was caused by those not preserved by ice being silted up, it would show that the process of filling up lakes is almost always very rapid, and therefore that no lakes can be very old. The ten thousands of existing lakes must therefore all have been originally formed just before the commencement of the glacial epoch, and in a time not so long as has since elapsed; and yet, during the whole time that has since elapsed, the process of lake forming must have entirely ceased over more than one half of the globe! Another, though a minor difficulty, is that it is necessary on this hypothesis to suppose that the time the glacial epoch lasted was many times longer than the time which has elapsed since the ice left the lake basins, for we see that the existing lakes have been only to a very small extent silted up, whereas the supposition is that ninety-nine hundredths of the lakes of all the rest of the world were silted up during that period. I have gone a little into this general argument of distribution, because it is one that a man who knows very little either of geology or glaciers may put forward without presumption, and also because it seems to me to have been very much lost sight of in the discussion of this question. We can all see that a true account of the origin of lakes must explain their present most remarkable distribution, although very few of us may be able to form any sound judgment as to what angle will stop a glacier's motion up hill.

It would appear, then, that there is at all events a strong case in favour of glaciers having had something to do with the formation of lakes. I therefore examined with much interest into the peculiar arrangement and position of the small lakes of North Wales, to see if they gave any support to Professor Ramsay's theory or seemed inconsistent with it. We may conveniently group most of these lakes into:—1st, such as lie in more or less regular bowl-shaped hollows of the mountains; and 2nd, those situated in longitudinal valleys. Immediately beneath the peak of Snowdon are three great chasms, which contain small lakes at an average elevation of 2,000 feet above the sea. On the east is Glas llyn, on the north are the two small lakes of Cwm glas, and on the west are the three little lakes of Cwm Clogwyn. All these lie in irregularly bowl-shaped valleys with a comparatively narrow opening; they all spread out and are larger within than the entrance to them would lead one to expect. Another feature they have in common is a comparative flatness of bottom. From below you have to climb a steep ascent or even a precipice to reach them, but when you have surmounted this you find a rugged undulating surface spreading out to the foot of the precipices which every where surround it. Cader Idris has two somewhat similar chasms containing lakes, and on carefully examining the Ordnance maps we see that there are numbers of such lakes around the higher mountains, occupying lofty bowl-shaped chasms with a more or less narrow exit. One of the largest of this class of lakes is Llyn Llydaw, which is more than a mile long and lies right across between two spurs of Snowdon, which close round it so as to leave a very narrow entrance. How these valleys were originally formed it is not very easy to understand, unless they can be connected with varying texture and resistance of the rocks. The symmetry of their arrangement around or on each side of lofty mountains is against this supposition, and I have been often inclined to think that they must owe their peculiar form to marine action during the various submergences the country has undergone. However this may be, it is evident that such a form of ground being already in existence when the glacial period came on, the ice must have accumulated in these crater-like hollows to a great height, and pressing forcibly on a nearly flat or undulated bottom while in slow but continued motion outwards, could hardly fail to deepen the basin here and there and thus form the little lakes we now see.

The second class of lakes or those in longitudinal valleys are generally situated at a much lower level, and are as a rule larger than the mountain tarns just described. The two lakes of Llanberis, together more than three miles long, are good examples of this class, and illustrate very clearly their characteristic peculiarities. There is a drainage into these lakes of about twenty square miles of country, bounded on both sides by mountain ranges over 3,000 feet high. The whole of the glaciers from these had to pass out between the ridge of the Clegr and that which descends from Cefn du, forming a pass about half-a-mile wide, while the shores of the lakes are all along bounded by steep and lofty slopes which would throw the whole weight of the accumulated ice into the nearly level trough between them. That the grinding power here was very great is evidenced by the fact of the shores of these lakes presenting finer cases of striation and grooving, of mamellation, and of complete planing off of the softer rocks, than are perhaps to be found any where else in Wales. Now most of the other lakes show exactly the same arrangement,—wide upland valleys with many tributaries above them, and below them a sudden narrowing of the valley by projecting spurs. This can in most cases be sufficiently seen on the Ordnance maps, but it is still more striking to look down at the lakes themselves from a moderate elevation. Look at the two ridges that meet together at an angle and shut in the valley at the lower end of Llyn Ogwen, or the precipitous slopes that confine Llyn Cwellyn, west of Snowdon, and Talyllyn, south of Cader Idris. In these and most other cases the valleys containing lakes are of very moderate inclination or nearly flat, so that the motion of the glacier would be slow and would chiefly arise from pressure. When therefore a sudden narrowing of the channel occurred, the ice would necessarily accumulate just above the obstruction, and thus give that increased weight and grinding power which are exactly the conditions said to have produced lake basins. Without going any further into particulars, I may state generally that the situation and surroundings of many of the lakes of North Wales are just such as ought to exist if Professor Ramsay's theory be the true one.

As a glacier can only be now grinding out a lake basin in the very thickest part of its course, it is very difficult to see the operation going on. At the same time so much is known about glaciers, and so many of the facts bearing upon this question are admitted by all, that some conclusions seem quite clear. For example, all admit that glaciers do (or once did) grind down the rocks over which they pass, to some extent. The grinding is caused chiefly by the weight of the glacier, and therefore where the glacier is thickest the grinding will be the greatest. Glaciers behave like a very thick semi-fluid mass, flowing and filling up channels of varying widths, and therefore accumulating where there are obstructions to their free passage. Now where such an accumulation takes place in a valley of tolerably uniform slope, there will be more weight and more grinding power than elsewhere, and thus hollows must be formed. And a hollow once formed the ice is there so much thicker and the pressure so much greater, and thus the hollow *may* increase more rapidly the deeper it goes. Then there comes the objection, that when the hollow is deep the ice at its bottom will be motionless, the upper layers sliding over the lower ones.

But who really knows this? It is a pure supposition; and there seem to be as good arguments on one side as on the other. And who, of all our philosophers previous to direct observation, would have supposed that glaciers could flow at all, and retain their form and continuity? The fact seems to be, that these huge ancient glaciers, spreading over hundreds of miles of flat country half-a-mile thick, are too vast for us to say what they could have or could not have done.

It is proverbially hard to prove a negative, and at present there is really no positive theory before the world, except Professor Ramsay's, that in any way explains either the overwhelming proportion of lakes situated in glaciated regions—or the fact that so many of the great lakes of Switzerland and Italy are situated exactly where they should be if they were ground out by glaciers,—or that the size and depth of the lakes correspond to the admitted size and thickness of the ancient glaciers. Many who oppose this theory will perhaps say that they admit it to be good as regards the smaller lakes and tarns, but uphold the elevation and subsidence theory for the larger ones. But this will in no way avoid the difficulties of distribution I have already pointed out, since the large lakes are very numerous and, as well as the small ones, abruptly cease before reaching the limits of the ancient glaciers,—limits, it must be remembered, traced before this theory was enunciated, and by men who even now do not all adopt it. Again the lakes form such a continuous series in position, form, and magnitude, that the presumption is against their having been formed by two quite distinct processes. Lakes have, no doubt, been sometimes formed by disturbance, tilting, or subsidence; but these are evidently exceptional causes, and are not to be assumed in any particular case unless they can be proved.

In connection with this subject, I may allude to one main point of difference which has existed among geologists almost since the subject first attracted attention, and which still exists. It is the question whether the glacial phenomena, so abundant over the whole of the northern half of North America, have been produced by enormous aërial glacial masses, covering at once or at different times the whole country,—or by icebergs floating down over it and grating along a shallow sea-bottom. Agassiz first propounded the "glacier" theory, and still upholds it. Sir W. Logan supports the same theory, and Professor Ramsay of course considers that the vast American lakes are to some extent a proof of it. On the other hand Sir Roderick Murchison, Sir Charles Lyell, and Mr. Dawson, all geologists of the greatest eminence, maintain the "iceberg" theory. Exactly the same difference of opinion occurs as to many other countries, such as North Russia, Finland, and even Scotland, but we will now consider America only, because I wish to state one difficulty which I cannot find alluded to in all that has been written on the subject in this country. The iceberg theory supposes that all the lake regions of North America were about a thousand feet under the sea at a very recent period, that the country was then ground and striated by icebergs, and has since risen to its present level. Now the great lakes, Michigan and Huron, are a thousand feet deep, their bottoms being about four hundred feet below the sea-level. When the land rose up these vast basins must have been full of salt water. What has become of it? No doubt it would soon run off at the surface, and be replaced by fresh, but as a mere physical problem, would *all* the salt water from a thousand feet deep be carried off by the influx and efflux of fresh water? Has water ever been brought up from the bottom of these lakes, and is it as fresh as that of the surface? *

But even if no trace is or ought to be found of the salt-water lakes that must so recently have existed, a difficulty of a totally different nature arises. These lakes and all the lakes and rivers north of them to the Arctic ocean now contain great abundance and variety of fresh-water fishes, and among them are many found in the lakes only and some entirely confined to single lakes. There are about twenty-two of these American lake-fishes described by ichthyologists, most of them quite distinct and well-marked species, found nowhere else in the world. About twelve are confined to the group of the Great lakes, and there is one distinct genus of the perch family (established by Cuvier) which has never been found except in Lake Huron. Now the glacial epoch is post-pliocene; that is, it is within the period of existing species. The mollusca were all identical with those now living; the vertebrates have been changed a little, but chiefly by the extinction of some species. How then are we to explain the occurrence of so many peculiar species and one *peculiar genus* in fresh-water, lakes the whole district around which was so recently under the sea? It may be said that the same difficulty affects the glacier theory, for if that be true, the lakes were only made by the ice and were not in existence till it left them. To this it may be answered that the country round the lakes in every direction was in existence though the lakes were not, and we need not suppose the whole land to have been covered with ice at once. It probably took different directions

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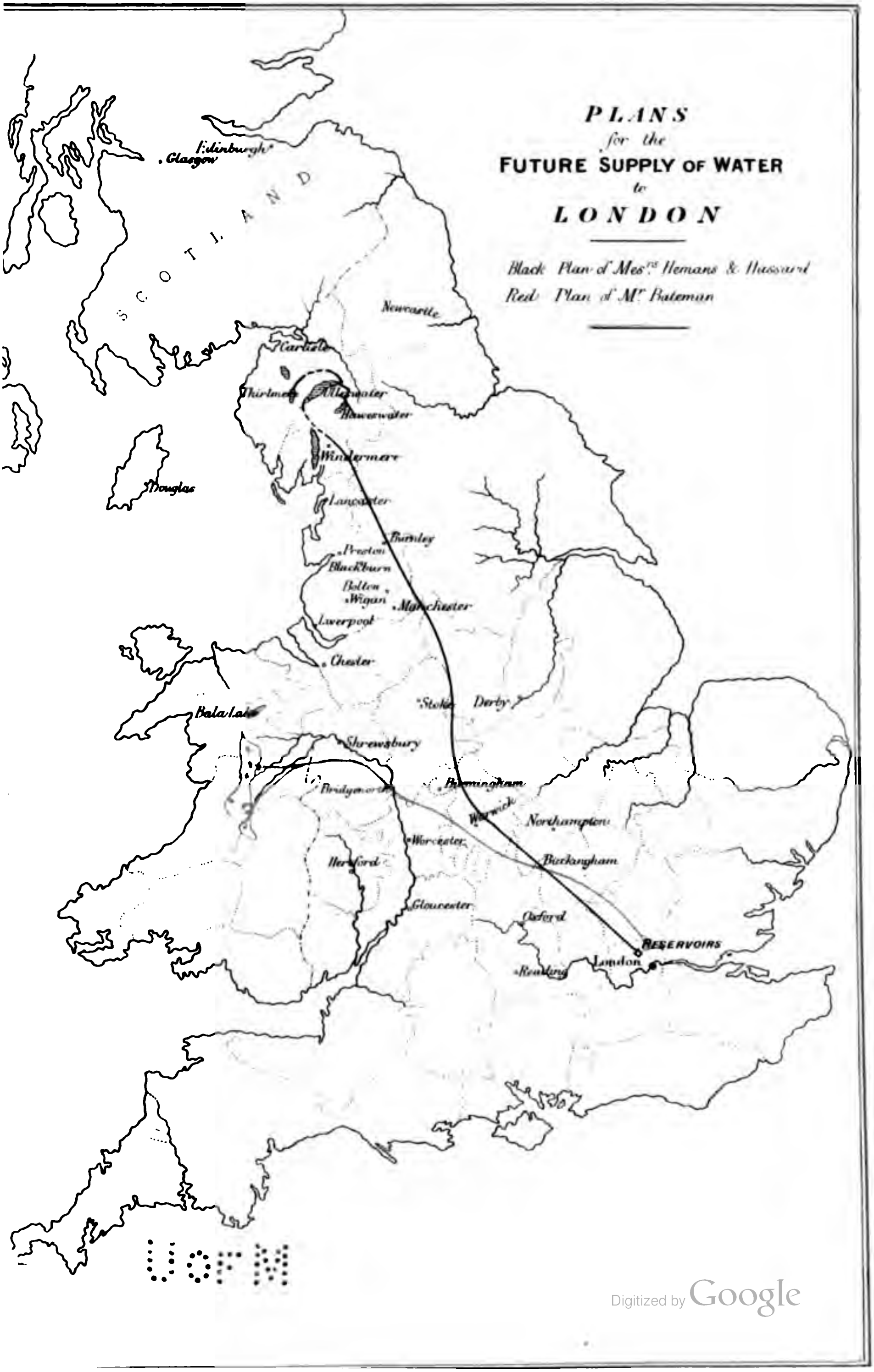
* I am informed by an eminent physicist, that by the process of diffusion the whole of the salt water would no doubt in time be carried off.


PLANS
for the
FUTURE SUPPLY OF WATER
to
LONDON

Black Plan of Mes.rs Hemans & Hassard
Red Plan of M.r Bateman

at different times, according to slight changes of climate and slow movements of the surface, and it is in accordance with all we know of the laws that have determined the distribution of animals, that so striking a modification of the physical geography of a country as the formation of thousands of lakes should lead to many changes and restrictions of the ranges of all animals, and especially of the fishes. The lakes may have proved more congenial to some which had hitherto been confined to one or two streams only, and may have preserved others from extinction which were just dying out. But on the iceberg theory the difficulty is immensely greater; for all the country north of the lakes (and much also south of them) as well as westward, almost to the bases of the rocky mountains, is so level that it must have been all under the ocean together; and it becomes difficult to understand where the great variety of fishes now inhabiting the streams and lakes of these regions can have come from, or how in so comparatively short a time they can have become modified into distinct local species. I leave this interesting ice-problem to those among my readers who take an interest in the great case of "Glacier *v.* Iceberg," now being argued in the High Court of Physical Science.

V. THE FUTURE WATER-SUPPLY OF LONDON.

By Edward Hull, B.A., F.G.S., of the Geological Survey of Great Britain.

The next Session of Parliament will probably be occupied with the consideration of two rival schemes for the supply of the Metropolis with water from distant sources, planned by engineers of eminence on gigantic proportions. That some distant source of supply is needed to replace the present arrangement, has been for some years foreseen by those who have taken an interest in the matter. Not only is the water from the Thames, the Lea, and other sources from which the Water Companies draw their supplies, destined shortly to become insufficient for the requirements of the inhabitants, but it is far from pure, containing in sensible quantities not only the salts of lime and magnesia which render it "hard," but organic matter derived from the villages and towns situated along the banks of these streams. Now of all the disadvantages which can effect a large city none is more intolerable than the want of pure water. It is a prime necessity of health and comfort, which every day's experience renders more obvious; nor can we doubt that the deadly effects of cholera in the East of London received an impulse, amongst other causes, from the impurity of the water supplied to the inhabitants of those districts.

Of all cities in the world the Metropolis of the British Empire ought to be the first in procuring for itself all the elements of healthful existence. It has a population of 3,000,000 souls, ever increasing. It is the residence during some part of the year of the Court, the Parliament, and the aristocracy of rank and intellect: it is the common property, not of a county or a district, but of the nation, and hence whatever affects its social condition interests the nation at large.

We should like to know from those enthusiastic philanthropists, the total abstainers, for whose opinions we entertain respect, whether such of them as may be residents in Glasgow, Manchester, Liverpool, or Birmingham, ever make the hazardous experiment of quaffing a glass of cold water fresh from the cistern or pipe in the city of London. If so, we venture to think their principles must sustain a severe test on such an occasion. For ourselves we are perfectly sincere in saying, that unless the water were previously boiled, it would require a large sum to induce us to perform a feat to which we are by no means unaccustomed in many of the large towns of the North. Boiling and filtration will no doubt render London water to a great degree innocuous, but it certainly does not render it palatable; and it can scarcely be denied that a supply which requires in its use such precautions is not adapted for general consumption.

No blame can be attached to the Water Companies for this state of things. They have endeavoured to turn to account the sources which were conveniently at hand, and the water drawn from them undergoes a process of filtration through sand and gravel. But it ought to be thoroughly understood, that no such process can eliminate the soluble or microscopic ingredients which render water derived from an inhabited district unfit for human uses. That too-celebrated London pump, which was the cause of death to 600 persons, is said to have yielded water which was apparently clear and good.

The water-supply of a large town ought to be derived either by pumping from considerable depths in the solid strata in a thinly inhabited district, or by utilizing the streams which descend from mountainous tracts where the population is scant and the rainfall abundant. The position of London renders it admirably adapted for receiving its water-supply from wells. The London basin is indeed a great natural reservoir, from which large quantities of water are already obtained by wells sunken through the Tertiary Clay into the Chalk formation, and is capable of yielding much more. Even were the supply from the Chalk and Green Sand exhausted, the Oolitic formation—including the Coralline Oolite, and the Lower Oolite of Gloucestershire, Somersetshire, and Oxfordshire—forms a very large tract of water-bearing strata, from which vast quantities of water might be obtained by pumping, at elevations varying from 400 up to 900 feet. If we project on the map a right-angled triangle, having its base formed by a line stretching from Salisbury Plain to the Cambridge Hills, and its apex in Kent, we shall have an area of not less than 1,500 square miles of water-bearing Cretaceous rocks, from which, if the whole of the water which percolates were utilized (after making deductions for local supply and the area covered by London clay, and loss), ought to yield 150,000,000 gallons per day, giving 50 gallons per day to each inhabitant of London.*

If to the above be added the area of the Lower Oolite from its outcrop to the margin of the Oxford Clay, we have a tract composed of water-bearing strata of even larger extent; but owing to irregularities, and interruptions in its horizontal range, scarcely so well adapted as the Chalk for the supply of large quantities of water from wells. Nevertheless the yield from this tract might probably be set down at 100,000,000 gallons per day, while very large quantities could be tapped from the springs which now form the sources of the Thames, Isis, and other streams. An idea of the quantity of water which might be derived by pumping from the southern slopes of the Cotteswold Hills may be gathered from the fact, that many of the streams, owing to the porosity of the Oolite rock, lessen in volume while flowing over it. Thus, it is stated that the Churn loses as much as 3,000,000 gallons per day before it joins the Thames at Cricklade; † and this is only one of several others similarly constituted. This water percolates into the rock, and escapes in springs somewhere probably along the western slopes of the hills, but certainly not into the watershed of the Thames. There are also springs of extreme purity and persistence bursting forth from the base of the Chalk and Upper Greensand in Berks and Wiltshire, besides those which feed the Yedding, Brent, Lee, Roding, and other small streams which join the Thames eastward of Teddington. ‡ To tap these springs at their sources, and conduct them by pipes and open channels to the reservoirs, as also to utilize to some extent by pumping the internal resources of the strata, which we have shown to be ample, is not we conceive beyond the power of engineering enterprise, and may perhaps be worth discussion before more elaborate schemes are undertaken.

The objections to a proposal which would necessitate the employment of machinery on so large a scale are obvious. A large number of reservoirs to be constructed in districts where the land is valuable would be necessary in addition to those now in existence in, and around, London. The expense of superintendence at each pumping station would be both large and permanent; but another objection, and one which is urged against the present supply, would apply even with greater force to the one here referred to,—the water would certainly be "hard," as it would be derived entirely from calcareous deposits. An idea of the quality of such water may be gathered from that of the well at Thames head, pumped for the supply of the Gloucester Canal, which on analysis was found to contain 18 grains per gallon of solid matter, of which 4 grains were organic.*

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* Allowing one million gallons to every five square miles of area; deducting one-third for the latter and one-fourth for the former items.

† Mr. J. Bailey Denton: Letter to 'The Times,' October 15, 1866. ‡ Ibid.

Having thus sketched out the general features and pointed out the advantages and some of the disadvantages of one plan for the future supply of the Metropolis—of the possibility of which there can be no question—and which amongst other advantages has that of being in proximity to the centre of demand, we propose now to consider the two great schemes which have been elaborated by Mr. Bateman on the one hand, and Messrs. Hemans and Hassard on the other.

Mr. Bateman has the advantage of having been first in the field, for his proposal was published in November of last year, while that of his rivals is dated 1866; we may also add that the former bears marks of more careful elaboration than the latter, and is accompanied by more detailed information.

The authors of both schemes naturally commence by stating the growing objections to a continuance of the present sources of supply; Mr. Bateman, however, laying more stress on the subject of hardness, on the ground, first, that soft water is economical, and secondly, that the use of hard water is productive of many diseases of a painful character, which are entirely absent in communities where the soft waters of the Millstone Grit and the primitive formations are used; and he assures us, on estimates which were calculated in the introduction of the Loch Katrine water into Glasgow, that the saving to the inhabitants of London by the substitution of water as pure as that now supplied to Glasgow would not be less than 400,000*l.* per annum in the use of soap, soda, tea, coffee, and chemical substances.

As the engineer of the Glasgow and Manchester Waterworks, Mr. Bateman, with reasonable partiality, compares the cases of these towns with that of London, in which the proportions in the matter of hardness alone are as 1° to 12° or 16° in the former instance, and 1° to 5° or 8° in the latter, according to Dr. Clarke's scale; and in this respect the following table will enable the reader to judge for himself:—

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* Analysis by Mr. Horsley, County of Gloucester analyst, given in Appendix B to Dr Wright's 'Report on the Water-supply of Cheltenham,' 1863. The water is pumped from the Great Oolite formation.

Comparative Statement of Quality of the Waters supplied to Glasgow, Manchester, and the Metropolis from 1856 *to* 1865.

Locality.	Mineral Impurity. Grs. per gallon.	Organic Impurity. Grs. per gallon.	Hardness.
GLASGOW—(Loch Katrine)	1·17	0·90	0·8
MANCHESTER—(Moors of Millstone Grit)	4·66	0·75	2·25
LONDON—Grand Junction (Thames)	Max. 22·59 Min. 17·15	Max. 1·38 Min. 0·68	Max. 14·87 Min. 12·67
West Middlesex (Thames)	Max. 21·20 Min. 16·62	Max. 2·48 Min. 0·70	Max. 14·40 Min. 12·18
Chelsea (Thames) . . .	Max. 22·79 Min. 17·11	Max. 1·42 Min. 0·84	Max. 13·80 Min. 12·67
Southwark and Vauxhall (Thames)	Max. 21·19 Min. 17·81	Max. 1·37 Min. 0·98	Max. 13·59 Min. 12·46
Lambeth (Thames) . . .	Max. 22·40 Min. 17·75	Max. 2·80 Min. 1·01	Max. 13·00 (nearly) Min. 13·16
New River	Max. 21·88 Min. 16·70	Max. 2·52 Min. 0·45	Max. 13·45 Min. 12·46
East London	Max. 24·80 Min. 17·99	Max. 2·80 Min. 0·63	Max. 15·50 (nearly) Min. 13·30
Kent	Max. 27·70 Min. 24·60	Max. 1·61 to 3·28 Min. 1·37	Max. 17·71 Min. 11·36

In reference to the above table, it is right to state that there are considerable variations in the ingredients, depending on the season of the year and the amount of rain. Most of the minimum quantities were obtained in September, 1865, after a dry season. The analysis of the Loch Katrine and Manchester Waters have been supplied to us from a private source.

It may be assumed that there are only two districts in Britain available for the supply of London by gravitation, namely, North Wales and the Lake Country. Mr. Bateman's scheme applies to the former; Messrs. Hemans and Hassard to the latter. In both of these districts the rainfall is abundant, and the elevation at which it is discharged admits of conveyance from the sources to the points of delivery without the aid of machinery; an essential element in a project of such magnitude.

Mr. Bateman starts with the principle that no scheme is worthy of attention which would bring less than 200,000,000 gallons of water per day. He proposes, therefore, to take the head waters of the river Severn, consisting principally of the streams called the Wyrnwy, the Banw, the Tarannon, and the Ceryst, which rise on the eastern flanks of Aran Mowddy, Dinas Mowddy, and Plinlimmon, draining an area of 130,572 acres, over which he assumes a minimum rainfall of 36 inches per annum. This estimate is obtained rather by the analogy of the physical features and geographical position of this district with that of the Cumberland lakes, where the rainfall has been determined by Dr. Miller, from observations extending over ten years to reach 89·93 inches per annum. The physical conditions of the two districts are not very dissimilar, and we may allow that the estimate of Mr. Bateman as regards the quantity of supply is within the mark.

The water of these brooks Mr. Bateman proposes to impound in six artificial reservoirs, four of which are of very large dimensions; from these it will be conducted by two aqueducts, each of about 20 miles in length, to Marten Mere, where a junction is to be effected. From this point the joint volume will be guided by a single aqueduct, crossing the river Severn at Bridgenorth, by means of inverted syphon pipes, and passing near to the towns of Stourbridge, Bromsgrove, Warwick, Banbury, and Watford, to the high land near Stanmore, where extensive service reservoirs must be constructed at an elevation of at least 250 feet above Trinity high-water mark. From these reservoirs the water will be delivered to the City at "high pressure," and under the "constant supply" system. The length of the aqueducts will be 171 miles, to which must be added piping from the service-reservoirs to London, about 10 miles, making a total distance of 183 miles. The cost of the whole of these works is estimated at 8,600,000*l.*, supposing the whole of the proposed supply to be actually obtained, but as 120,000,000 gallons would be sufficient for the present supply, the sum of 7,500,000*l.* may be considered as the actual amount to be raised.

Mr. Bateman proposes to purchase the works, reservoirs, and mains of the existing companies (exclusive of any of the New River supplies, which may still be retained for trade purposes) by capitalizing the present dividends and interests at twenty-five years' purchase, and to invest the whole property in some public body, similar to that of the Metropolitan Board of Works, with power to levy the rates necessary for the payment of interest on outlay and for the working expenses. It is natural to suppose that the existing companies would be willing to dispose of their works to such a body on condition of receiving the usual dividends secured on rates levied upon the whole property of the Metropolis.

The scheme of Messrs. Hemans and Hassard appears at first sight even more stupendous than that we have just been considering, as the distance of the source of supply is 240 miles as against 183, but it possesses advantages which appear fully to counterbalance the drawback consequent on the additional length of conveyance. The authors propose to make use of the waters which fall on part of the northern flanks of the Cumberland mountains, and which feed the lakes of Thirlmere, Ullswater, and Haweswater, together with some adjoining brooks. The plan consists of conducting by means of aqueducts the waters of both Thirlmere and Haweswater into the lower end of the central Lake of Ullswater, and from the head of the lake to construct an aqueduct, passing under Kirkstone

Pass by tunnelling, and from thence through the districts of North and East Lancashire, North Staffordshire, and Warwickshire (avoiding all coal-fields), to a large service reservoir to be constructed to the north of Harrow, from which the water is to be supplied at an elevation of 220 feet above high-water mark to the houses of the Metropolis, utilizing, as Mr. Bateman proposes, the present companies' means of distribution. The entire area of drainage is over 177 square miles, at altitudes varying from 500 to 3,200 feet above the sea, the mean being 1,400 feet; with an additional area remaining for increased supply when it becomes necessary.

The disadvantage of this scheme as compared with that of Mr. Bateman is the greater distance of conveyance, besides the driving of a tunnel of seven miles in the very hard rocks of which the mountains between Windermere and Ullswater are composed, which of itself is estimated to cost 350,000*l.* The total expenses is placed at 9,650,000*l.* as against 7,500,000 of the competing scheme; but the former is subject to a deduction on account of a proposed distribution of 50,000,000 gallons per day to the populous towns of Lancashire lying along the line of the aqueduct. This we consider a valuable feature in the scheme.

It is well known to those resident in Lancashire, that many of the large populous towns are ill-supplied with water for household and manufacturing purposes. Some of these towns, such as Liverpool, Blackburn, Bolton, and Wigan, owing to the rapid increase of population, are likely in a few years to be reduced to great straits; and even now during very dry seasons, such as the early part of last summer, some of these towns are put on short supply. The introduction therefore of 50 millions of the pure and soft waters of the Cumberland lakes to supplement the present sources would be a very great boon to these districts, and the rental to be derived therefrom would, we have little doubt, more than compensate for the additional outlay which the plan of Messrs. Hemans and Hassard would involve. On this ground, therefore, we prefer the larger scheme.

But there is another advantage. There is no doubt that the great drawback to Mr. Bateman's plan is the construction of a number of large artificial reservoirs, subject to the accidents of all such constructions, however skilfully planned and executed. On the other hand, in the Lake district, nature herself has constructed rock-basins and reservoirs, altogether free from any such objections. It is true that in the proposed plan of Messrs. Hemans and Hassard the Thirlmere and Haweswater are to be raised by artificial embankments 64 and 42 feet above the present levels respectively; but these will be of less elevation than the embankments proposed by Mr. Bateman, which are not to exceed 80 feet, and are not of equal moment in reference to the general scheme, as it is not proposed to embank Ullswater—the largest by far of the three lakes.

As regards the comparative quality of the waters to be supplied from the two sources, the advantage would probably be found to lie with that drawn from the lakes: both, however, are sufficiently good for all necessary purposes. Of the waters from the Welsh rivers in Mr. Bateman's scheme, the analyses show the total impurity to vary from 2·6 grains per gallon to 7·24, and the hardness from 1·8 to 2·2. In the case of the lakes, the amount is 3·61 to 7·00, this latter being the amount of matter in the water of the river Lowther, which is to be utilized, and the degrees of hardness vary from 1·5° to 5·2°. There is, therefore, not much to choose between them, and both are vastly superior to the waters now supplied to London.

Taking a general view of the two plans, we may say that Mr. Bateman's has the advantage of shorter distance and smaller cost. On the other hand, the rival one has the advantage of natural storage-reservoirs, and of conferring a benefit on the inhabitants of South Lancashire; and we shall be well pleased if one or other of the schemes be carried out with as little loss of time as possible.

As regards the cost of carrying out either of these schemes, the authors endeavour to show that the taxation, as applied to the Metropolis, would not be greater in proportion to the rateable value of the property than that of several larger towns in the north, and would be even less than in the case of others; and, considering the interests at stake, Mr. Bateman ventures to hint at the propriety of Imperial assistance, should any difficulty be found in raising the required capital.

VI. RICHARDSON'S ETHER-SPRAY AND PAINLESS OPERATIONS.

Little do men of science think by what apparent accident it may please Providence to crown their long, unwearying, and often derided efforts to gain some great end, be it the alleviation of human suffering or the elevation of human intelligence. Little did Dr. Richardson dream, as he once entered a London ball-room, that the practical joke of an acquaintance would suggest to him the readiest means of rendering the human body insensible to pain, without at the same time endangering life or robbing the patient of consciousness.

Every one who is conversant with what is going on in the scientific world knows that the gentleman referred to has been for many years engaged in endeavouring to produce local anœsthesia, and about a year since it began to be rumoured in medical circles in London that he had succeeded in rendering diseased parts so completely insensible to pain by external appliances as to admit of surgical operations being performed in which the use of chloroform had previously been indispensable, and where it had often been followed by fatal results. He had for many years been applying substances to the surface of the body with a view to freeze the affected part, for he had arrived at the conclusion that the sense current in the nervous system is thermal and not electrical, and that therefore the proper means of producing insensibility in any part would be to rapidly abstract the heat from that part, but his success had been partial only, and the length of time occupied in preparing for the operation was such as to render the general introduction of his method impracticable. We purposely pass over his unsuccessful work (which was not, therefore, the less meritorious), in order that our limited space may be devoted to the account of what he has accomplished for the benefit of mankind; and, as already hinted, an apparent accident it was that crowned his efforts with success.

Whilst he was at a ball in London, in the year 1862, a lady approached him with one of Rimmel's vaporisers, and drawing his attention to the new discovery for ministering to man's—or we should, perhaps, rather say woman's—enjoyment, she blew a little of the vapour or spray of Eau-de-Cologne against his forehead. He was taken by surprise, and was still more astonished when, on feeling his forehead, he found it cold, and that part on which the spray had played wanting in sensibility. He told the lady she had discovered a means of producing local anœsthesia, but it was *he* who had discovered it. Nor yet was it by accident; for if the young lady had puffed her scent into the faces of some dozens of young dandies, the effect would simply have been to amuse or to annoy them, whilst a meaningless joke practised upon the person of a man whose mind was penetrated with one great object, and in whose thoughts that object was ever present, led to a discovery for which the human race will bless the discoverer in all time.

From the period referred to until the close of 1865, Dr. Richardson constantly but secretly studied the subject, and was engaged in experimenting with various volatile liquids and gases, and in the construction of a suitable apparatus for administering the spray, but although the process came into general use in the hospitals, as well as amongst the medical profession in London some months since, and a few country practitioners also apply it, its great advantages are not yet generally known, and it was not until the discoverer produced local anœsthesia on the arm of the President of the British Association, at Nottingham, and transfixed him with needles, that its wonderful efficacy began to attract public attention.

The first time the process was applied at all was in the case of tooth extraction on the 11th of December, 1865. The instrument used was one in which the ether was exposed to freezing mixture before being distributed in the atomized form, and Dr. Richardson has thus described the case:—

"The patient was a lady, who required to have five front teeth extracted. I had previously administered chloroform to this lady for a tooth extraction, but the inhalation had produced so much irregularity in the action of the heart and other disagreeable symptoms, that I considered it inadvisable to repeat chloroform, and she herself was only too ready to give the local measure a trial. The extraction was performed by my friend, Mr. Peter Matthews. On directing the ether spray first at a distance, and then closely upon the gum over the first central incisor on the left side, we observed, at the end of fifty seconds, that the gum had become as white as the tooth itself, and quite insensible. I then directed the vapour upon the tooth for twenty or thirty seconds more, and on the patient intimating that she did not feel, I suggested to Mr. Matthews to proceed. He extracted a very firm tooth without the slightest expression of pain. The process being continued in the same manner, he extracted three other teeth with the forceps. The fourth gave way, and had to be removed by the lever; but in all cases the result was equally good. Not a drop of blood was lost; there was no painful reaction; and the healing process proceeded perfectly."

The writer of this article has also had an opportunity of witnessing the wonderful effects of the spray in an operation performed on a near relative, and a brief account of it may not be uninteresting. She had long been suffering from a small tumour which had grown under the nail of the great toe, and the nail had been removed and various chemical substances applied, but after nearly two years' treatment it remained as painful as ever, and nothing was left but the excision of the affected part. At the house of a friend Dr. Richardson applied the spray, whilst one of our ablest metropolitan surgeons removed the tumour. The spray was administered with an instrument to be described presently, and in a few seconds the whole of the end of the toe assumed a white appearance, as though it had been poulticed for many days, but it was perfectly hard, and the circulation was effectively arrested. In a few seconds more the skilful hand of the surgeon had, with the scalpel and other suitable instruments, painlessly removed the tumour and with it a little of the bone, for it proved to have arisen from an abnormal growth of the bone, known as exostosis. After it was removed, the surgeon discovered that a little more bone would have to be clipped off: the ether-spray was again applied, without pain, to the open wound, and the operation successfully accomplished. A little bleeding, which began shortly after the operation was performed, accompanied by some temporary pain, not so acute as the patient had often suffered in the same part, was the only subsequent inconvenience, and the wound healed rapidly. This operation is usually an agonising one, and has hitherto been performed under the influence of chloroform, sometimes with fatal consequences. Afterwards, Dr. Richardson applied the spray to the hands of the writer and some of his friends, and it was found to vary in the rapidity with which it took effect. The writer's hand soon became livid, and he has no hesitation in saying, that within a few seconds (say five or six) after the ether was first applied, he could have cut off the part against which the spray had been directed without any sense of pain, for it was as *mummified* as if it had been buried for thousands of years in some catacomb. In less than a minute after the pumping process was discontinued, the circulation was completely restored, and nothing was felt excepting a slight sensation of burning.

We have given this brief account of the operation of Dr. Richardson's process, as witnessed and experienced by the writer, in preference to quoting cases from hospital reports, as it will convey to the general reader a better idea of its effect than mere quotations in technical language from the medical press; and, in like manner, it will be as well to state generally for what class of diseases and in what degree it is found to be effective, our information being derived from the best of all sources—the skilful operator referred to, who is one of the chief surgeons of a leading metropolitan hospital.

Before doing so, however, let us say a word concerning the apparatus employed; Dr. Richardson describes the instrument which he now uses, as follows:—

"The apparatus consists simply of a graduated bottle for holding ether; through a perforated cork a double tube is inserted, one extremity of the inner part of which goes to the bottom of the bottle. Above the cork a little tube, connected with a hand-bellows, pierces the outer part of the double tube, and communicates by means of the outer part, by a small aperture, with the interior of the bottle. The inner tube for delivering the ether runs upwards nearly to the extremity of the outer tube. Now, when the bellows are worked, a double current of air is produced, one current descending and pressing upon the ether, forcing it along the inner tube, and the other ascending through the outer tube, and playing upon the column of ether as it escapes through the fine jet. By having a series of jets to fit on the lower part of the inner tube, the volume of ether can be moderated at pleasure; and by having a double tube for the admission of air, and two pairs of hand-bellows, the volume of ether and of air can be equally increased at pleasure, and with the production of a degree of cold six below zero.

"By this simple apparatus, at any temperature of the day, and at any season, the surgeon has thus in his hands a means for producing cold even six degrees below zero; and by directing the spray upon a half-inch test-tube containing water, he can produce a column of ice in two minutes at most."

The use of ether spray, we are told, is efficacious in all minor operations where the medical practitioner considers the risk of administering chloroform too great to justify its application; for the removal of small joints, such as the finger or toe end; for the eradication of cancer when not too deeply seated; for all superficial tumours, abscesses, boils, and excrescences, such as piles, &c., for some of which the operations are very agonising. In fact, *in nineteen out of twenty cases where the knife has to be employed it is quite effective*, and renders the dreaded use of chloroform unnecessary. It is daily used at St. Bartholomew's Hospital, where they see 100,000 patients annually, and at other metropolitan hospitals: and in some cases it is applied in the more serious operations of removing the larger limbs, in hernia, &c. Where a leg or arm has to be removed, Dr. Richardson, or whoever may administer the spray, plays around the limb as the knife enters, but here difficulties arise which diminish its usefulness. The red colour of the flesh is no longer there, and the vessels cannot be easily detected; the process of amputation is greatly retarded, and, generally, it is not at present a favourite auxiliary in the operation. We trust, however, that these difficulties may disappear, for it has enormous advantages over the chloroform process, which often leaves after-effects as dangerous as the operation itself, and the complete stoppage of circulation which it causes must also be of great advantage to the operator.

But one of the most valuable results is where Dr. Richardson applies the vapour of a medicated ether internally, as in cases of internal hemorrhage, especially after confinements. Our readers are well aware how frequently such cases have baffled the ablest medical men, and how many poor creatures have bled to death whilst the medical attendant has looked on helplessly. By the new process the wound is reached and attacked by a styptic vapour which effectually stops the hemorrhage.

If, however, our readers desire to be more fully informed as to the present advantages of the application of Richardson's ether-spray, they must consult the medical journals, for we are unable to afford the necessary space to inform them further, and the subject is one with which we can hardly deal in a detailed manner in this periodical. One word, however, concerning the inventor and his treatment by the medical profession.

The first thought which naturally occurs to practical men, is that the invention must necessarily bring something far more tangible than fame to the discoverer. In the medical profession, however, it is not considered etiquette to patent an invention—why not we are at a loss to understand—and Dr. Richardson has freely given his discovery and the power to use his apparatus to the world. But the medical practitioners of London know how to appreciate the untiring zeal and earnest devotedness of a man who gives up wealth and professional *éclat* in their service and in the service of mankind, and they are manifesting their appreciation of Dr. Richardson's lengthened labours by contributions to a testimonial which shall in some small degree stand in place of the pecuniary results that might have accrued to him had he been less punctilious and more selfish; and in setting such an example to all who are likely to derive benefit from the inventor's toil, those gentlemen confer alike an honour upon Dr. Richardson and upon the noblest human calling.

We feel grateful, not only that we have been able to reap a benefit from the new discovery, but that we are permitted to add our humble tribute of praise to the indefatigable and disinterested discoverer of what will prove to be one of the greatest blessings that has ever been conferred by Providence upon the human race.

VII. THE METEOROLOGICAL DEPARTMENT OF THE BOARD OF TRADE.

As the reconstruction of the Meteorological Department is at present engaging the attention of Government and scientific men, we venture to make a few remarks on the subject; which may at some future time be extended as occasion requires. In these remarks, however, we shall not enter into scientific details; but would rather regard the project from a business point of view.

In the first place, we take it for granted that Government ought to lend its support to the systematic prosecution of Meteorology; for not only are Meteorological laws of immediate practical importance, but in order to discover these laws, the united action of many observers is required; and this united action can best be obtained by an influence and support such as Government can give.

In the second place, it would appear that the following form the most prominent practical benefits which may be anticipated from the successful prosecution of Meteorology.

(1) A determination of the ordinary climate, or Meteorological condition of the various places in this country, and of the various regions in the ocean.

(2) A determination of the laws which regulate storms and all similar *abrupt* affections of the Meteorology of a place or region.

(3) Besides the ordinary climate of a place and the abrupt disturbances thereof, it may ultimately be possible to understand the cause of long continued peculiarities of weather, whether on land or at sea, such, for instance, as the very wet autumn we have just experienced, and perhaps even to predict the approach of such peculiarities.

In the third place, in order that the country may derive the fullest possible benefit from a systematic prosecution of Meteorology, it would seem to be necessary that there should be *two* bodies of Officers in communication with each other; but otherwise acting independently of one another.

There ought to be a body of men whose duty it is to investigate meteorological laws, and to publish them when discovered; and also a body of men whose duty it is to make a practical application of these laws, when once they have been discovered.

Thus, for example, a knowledge of the climate of various places is desirable in those who take charge of the Public Health, and in those who take part in Agriculture; while again a knowledge of oceanic climate, especially of the prevailing winds and currents of the various oceanic regions, is of great importance to mariners. But the scientific officer who investigates the climate of a place ought to be distinct from the officer whose duty it is to make a practical use of this knowledge of climate; and also from the officer whose duty it is to see that a knowledge of the prevailing winds and currents is properly made use of by seafaring men.

To take another example, a knowledge of the laws which regulate the progress of storms is of great importance to a maritime nation like ourselves, and by means of the telegraph may be made of immense service, as the results achieved by the late Admiral Fitzroy have clearly shown; but the scientific officer who investigates the laws of storms ought surely to be distinct from him who telegraphs to ports an intimation of an approaching storm; in fine there ought to be what may be termed a *legislative* and an *executive* department, distinct from one another.

Having thus endeavoured to point out the necessity for this separation of offices, we will in the remainder of this short article confine ourselves to the *legislative* department, and say nothing about the *executive*; because foreign considerations are mixed up with the executive in this as well as in other departments, and the most just and admirably conceived set of rules might be thought to infringe too much upon the liberty of the subject.

Let us now therefore lay before our readers a few general considerations regarding the best machinery for discovering scientific laws.

It would be desirable to introduce into some half-a-dozen stations in the British Islands self-recording instruments all on one plan;

such instruments would give results which cannot be furnished by the very best body of eye-observers: and we understand a system of this kind is under the consideration of Government.

Besides these self-recording observatories, numerous stations in the British Isles and numerous vessels at sea ought to be supplied with instruments all verified at some central Observatory. Care ought also to be taken by inspection and otherwise, that the observations are properly made.

The whole body of observations both by land and sea ought to be discussed under the direction of one general Superintendent, overlooked if need be by a scientific board. This general superintendent might also with propriety have under him two responsible officers; one to take charge of the land, and the other of the sea observations. The general superintendent should likewise be well acquainted with those branches of science, which are or may prove to be akin to Meteorology.

We have only to add, that the executive meteorological officers ought immediately to be informed of the observational laws when they are discovered; and these ought also to be communicated to such of the scientific and general public as are interested in the subject.

In conclusion, we venture to think that a Government which treats the matter in such a way, would be sure to gain the confidence and favour of the scientific world.

VIII. THE PUBLIC HEALTH.

The East End of London. By Edwin Lankester, M.D., F.R.S.

London is not more favourably situated for health than other towns of England. The chief part of the great Metropolis is built directly upon the bed of clay which is deposited in the great chalk basin, whose edges rise round London on every side. This basin is divided into two sides by the river Thames: the larger population is on the north side. On this side stand the two great commercial and social centres of London—Westminster, with the Houses of Parliament and Buckingham and St. James's Palace; and the City, with St. Paul's Cathedral, the Mansion House, and Guildhall. The population of London is now nearly 3,000,000. It is not governed by one Municipality, as other cities of the empire. The Corporation of London, with its Lord Mayor, have control over the affairs of only a very limited number of citizens. The Metropolitan Management Act recognized upwards of forty Local Boards of Works, or Vestries. Hence London, in its general management is at a disadvantage as compared with almost every other city of the empire. With this divided authority it is much to the credit of London that she can claim to be the healthiest city in the United Kingdom. During the last ten years the death-rate has been as low as 23 in the 1,000, whilst during the first four months of this year, 1866, the death-rate was lower than any of the thirteen cities whose death-rate was published weekly by the Registrar-General. The average death-rate of these four months was 25 in the 1,000. Since that time the death-rate of London has been up as high as 35 in the 1,000, but that was during the month of August when the Cholera was raging in the East. Even during that sad month the mortality of Newcastle-upon-Tyne was as high, and that of Liverpool much higher, without any outbreak of Cholera in the former.

But London is not one city; it is a congeries of cities. The whole death-rate may be low, but there are spots where it is excessive. Taking as an instance the parish of St. James's, Westminster, we find the death-rate here during the past ten years to have been 20 in the 1,000; but on examination it will be found that in one district the death-rate has been as low as 12 in the 1,000, whilst in another it has been as high as 25 in the 1,000. So in many of the parishes of London, when the bills of mortality are low, there are plague-spots which present for a few hundreds or thousands of people a mortality as great as that to be found in any other town throughout the country.

The health of London has undoubtedly been benefited by the general Act passed in 1855 under the name of the Metropolitan Management Act. This Act gave to the various Local Boards of Works or Vestries the power of electing a central body, the Metropolitan Board of Works, in whom the management, making, and repairing the sewers of London was vested. One of the great acts of this body has been the construction of sewers, by which the whole of the sewage of London is carried several miles beyond its boundaries, and emptied into the river Thames. It is worthy of note that this great work is now nearly completed, and that the only locality not connected with the new Main Drainage Works, is that district in the East End of London which has lately been the seat of the ravages of Cholera.

Another great good effected by the Metropolitan Management Act was, that it made it compulsory on the Vestries to elect Medical Officers of Health. To these officers was committed the duty of superintending the health of the district to which they were appointed. Under this Act forty-six Medical Officers of Health were elected in the various parishes of London. In some instances these gentlemen have been supported by the Vestries who appointed them, and material sanitary improvements have taken place as the consequence. But in a large number of instances the Medical Officers of Health have been obstructed and opposed in all their efforts to improve the sanitary state of their districts. Their salaries have been reduced, their suggestions neglected, and in too many instances they have found it wise to say and do as little as possible for the sanitary improvement of their parishioners. The new Act gives powers to the Vestries to appoint Sanitary Inspectors, and where these officers have been appointed they have been of great and permanent utility. But in many parishes of London no Sanitary Inspectors have been appointed at all, and there are whole districts, including thousands of people, who have never been benefited in the slightest possible manner by the passing of the Metropolitan Management Act. At a meeting of the Association of Medical Officers of Health on the 16th of August, at the time when Cholera was at its height in the East End of London, Dr. Sarvis, the Medical Officer of Health for the Bethnal Green district, stated that the Orders in Council had found his Vestry "entirely unprepared," and "so far from their being inclined to carry out his suggestions as Health Officer, they, in fact, opposed him." "There was scarcely any house-to-house inspection; in fact, there were only three Sanitary Inspectors appointed for a district numbering upwards of 115,000 inhabitants." He added, "the adjoining parishes were quite as bad." Here, then, we have the most competent testimony to the fact that the East End of London had not only neglected taking advantage of the Metropolitan Management Act, but at the very time that the population was being carried off by hundreds in a day, they were opposing their Health Officers and refusing to supply the only means by which the disease could be stayed.

The advantage of an organization with a Medical Officer of Health at its head has been clearly demonstrated in London during the recent outbreak of Cholera. There was no reason to suppose, from the general character of the disease in its progress from Asia through Europe, that the present epidemic would be less fatal than it had been in 1849 or in 1854, but the numbers who have perished in London have been much less than in either of those two epidemics. Before the epidemic had fairly broken out in the East End of London, the Privy Council issued instructions to every Vestry, which compelled those bodies to take immediate action, and although these instructions were issued too late to be acted upon in the Eastern districts before the terrible explosion at the latter end of July, they were nevertheless very generally carried out in the Northern, Southern, and Western districts of the Metropolis. The principal measures adopted under their instructions were as follows:—

1. A Sanitary Committee, appointed by the Vestry, was constituted in every parish, to whom full power was given to take such measures as were found necessary for the prevention or arrest of the disease. The meetings of the Committee were regulated according

to the urgency of the outbreak; and the Medical Officers of Health attended these meetings, reported on the progress of the disease, and recommended what steps should be taken.

2. In most of the Metropolitan parishes where it was ascertained that Cholera had actually broken out, medical visitors were appointed to whom every case of Cholera and Diarrhœa was reported, and who went to every house where persons had taken the disease, and not only prescribed for and treated the sick, but inspected the house and reported its condition to the Medical Officer of Health, who met the medical visitors every day. The medical visitors also had power to order food, wine, and other stimulants that were necessary for persons suffering under Cholera or Diarrhœa.

3. Arrangements were made with dispensaries, hospitals, or chemists and druggists, for the supply of medicines ordered by the medical visitors at all hours of the night and day. Nurses were also engaged to be in readiness to attend on any persons who might immediately require assistance at their own houses.

4. The staff of sanitary inspectors was increased, and a house-to-house visitation made by them in those districts, where, from unhealthy arrangements, or over-crowding, Cholera was likely to break out. The inspectors were supplied with disinfectants, which they applied in all cases where persons had been attacked with Diarrhœa or Cholera; and in many districts water-carts containing a solution of carbolic acid were sent round to gulley-holes, and stable-yards, and other places where disinfectants were likely to be of service.

5. The clothes of all persons who had died of Cholera, and the bed and bed-linen in which they had slept, were immediately destroyed. The things thus destroyed were immediately replaced at the expense of the Vestry or parish in which the case occurred.

6. The surface well-pumps were directed to be closed, and the waters from cisterns and butts, where Cholera and Diarrhœa prevailed, were examined by the Medical Officer of Health; and all cisterns and butts were directed to be well cleansed at least once a-fortnight during the epidemic.

This will give a general idea of the measures taken in those districts of London where the fewest number of cases of Cholera have occurred. That these measures were not fully carried out in the Eastern districts of the Metropolis is well known. Whether that outbreak, and its subsequent development, could have been prevented altogether, may be questioned; but that its severity might have been mitigated and the mortality lessened to a large extent, had more active measures been adopted, there can be no doubt. The only excuse that Vestries and Local Boards make for their supineness in sanitary matters, is the expense, and yet who can doubt that by the saving of life and disease, the community would have benefited pecuniarily by ten times the amount that has been spent on sanitary measures. The difference between the mortality of the present epidemic in London, as far as it has at present gone, and those of 1849 and 1854, is as follows: From the 22nd to the 45th week of 1849, 16,525 persons died of Cholera and Diarrhœa. In 1854, 13,264 died in the same period, whilst in 1866 only 8,245 persons have died of these diseases. Taking the difference between the deaths of 1854 and 1866 in round numbers, it shows that 5,000 persons less have died. This is an enormous number, and would amply repay all the expenditure that has been bestowed on sanitary measures.

There has been, however, no saving in the East of London, where the proportion of deaths to the population has been greater than during the previous epidemic; thus clearly proving that Cholera is not less virulent where neglect courts its attacks, than it was during our earliest experience of its visitations.

The district of London which is known as the East End will be easily recognized by those who are not well acquainted with London, as lying on each side of the Great Eastern Railway. Starting from the Shoreditch Station, we have on the left the parishes of Shoreditch, Bethnal Green, and Old Ford, bounded by the Victoria Park, and terminating at Stratford. On the right of the line are Whitechapel, Stepney, Bow, and West Ham. Farther to the right, is the Blackwall Railway, which runs through Shadwell, Limehouse, and Poplar, to Blackwall. These last places are on the Thames. It is this large area which was principally attacked with Cholera. In some of the outlying districts the population is sparse, but in many other districts it is dense, poverty-stricken, and over-crowded. The neighbourhood of the Docks is especially over-crowded, and abounds with low public-houses, in which the poor and hard-working population indulge in large potations of bad spirits and adulterated beer. It is also this district that has felt, at present, little or no benefit from the new and costly system of sewerage which is now so materially improving the health of the rest of London. The one great medical institution of the East End is the London Hospital, which is situated in Whitechapel, and stands almost in the middle of the district. The population of all the parishes of the East of London may be roughly estimated at half-a-million.

On Saturday, the 7th of July, four deaths were registered from Cholera in London, but not one of them occurred in the East. On the 14th of July, 32 cases were registered, and of these, 20 occurred in the East. It is interesting to observe that these cases did not occur in a batch at one spot, but were distributed over the whole district. Thus there was 1 case in Shoreditch; 2 in Bethnal Green; 1 in Whitechapel; 1 in Stepney; 2 in Limehouse; 1 in

Mile End Old Town; and 4 in Poplar; and 1 each in other parishes. In the week ending July 21st, 346 deaths from Cholera occurred in London. This fatal explosion occurred chiefly in the poor districts of the East End of London: 39 cases occurred in Bow; 52 in Poplar; 43 in Limehouse; 30 in Bethnal Green; 33 in Mile End Old Town. On the 28th of July, 904 deaths from Cholera were reported, and of these 811 cases occurred in the six districts of Bethnal Green, Whitechapel, St. George's-in-the-East, Stepney, Mile End, and Poplar. In the week ending the 4th of August, 1,053 persons died of Cholera, of these 916 cases occurred in the East. In that week the disease had attained its greatest mortality, and how it fell upon the Eastern districts may be estimated by the statement of the Registrar-General, that whilst the mortality of the month from July 7th to August 4th was in the West district of London at the rate of 24 in the 1,000 per annum, it was at the rate of 82 in the 1,000 for the East of London! From that week the mortality gradually declined to the middle of the month of November. As the disease declined, it ceased more rapidly in the parishes which had been visited in the East than in the rest of London. As compared with the mortality of the epidemics of 1849 and 1854, the Cholera of 1866 has shown less disposition to retire than in those years. This ought to be regarded as a suspicious sign, and to lead the authorities in London not to relax in their sanitary efforts, lest the poison should lurk about, and be ready to break out in the more favourable weather of another year.

The most interesting question connected with this outbreak of Cholera in the East of London, is to what cause can its remarkable localization be ascribed? Not only has Cholera not spread alarmingly in any other great district of London, but in a large number of cases which occurred in other parts of London, they were clearly traced to persons having visited or come from the East End. The question of the origin of this outbreak has been largely discussed by the Medical Officers of Health, the Registrar-General, and the leading medical journals in London. Before this visitation, the history of the present epidemic on the Continent of Europe, and the outbreak of Cholera in England at Southampton and Theidon-Bois, near Epping, in Essex, in the latter part of 1865, had confirmed the view originally taken by the late Dr. Snow, that drinking-water was the great source of Cholera-poisoning. In his weekly return on the 28th of July, the Registrar-General remarked, that the district attacked was "essentially the part of London inhabited by its maritime population. The canals and the basins are full of foul water, and are apparently connected with the Limehouse Cut, the Hackney Cut, and the River Lea. The East London Waterworks' Canal draws its supply from the river at Lea Bridge, where there is a reservoir, and runs for a couple of miles by the side of the Hackney Cut, down to its other reservoir north of Bow, and near the Lea. The present Cholera field derives its waters from these works." From the date this was written up to the termination of the epidemic, accumulated evidence has all pointed to this one conclusion, that the water-supply of the district was the exciting cause of this awful visitation of Cholera.

At the same time, it should be remembered that up to the present moment no chemical or physical means exist by which the presence of Cholera poison, or any substance having a tendency to give Cholera, can be detected. No sooner had the Cholera appeared at the East End, than attention was directed to the chemical composition of the water. Dr. Frankland, of the Royal College of Chemistry, who gives a monthly analysis of the principal waters supplied to London, in the Registrar-General's Reports, had published an analysis of the water of the East London Company on the 1st of July, and after the Cholera had broken out, he again analysed the water on the 1st of August. We give the result of the two analyses:—

East London Company's Water.	Solid Matter in 100,000 feet.	Organic Matter in 100,000 feet	Oxygen required to Oxydize again with.	Degree of Hardness.
Collected 1st of July, 1866	24·38	1·94	·0344	16·0
Collected 1st of August, 1866	26·14	1·44	·0328	17·7

This analysis shows that, although the water contained less organic matter in August than in July, that nevertheless in July the water could not be regarded as unfit for drinking purposes. It has been sometimes supposed that water contaminated with a certain amount of organic matter, when taken by healthy persons, will engender a condition of the system in which the poison of Cholera conveyed through the air, will produce that disease. During the late epidemic of Cholera in London there has been nothing to support this theory. In many districts of London the surface well-pumps remain open, and are, indeed, in certain spots the only source of the supply of water in the neighbourhood in which they exist. The water of these pumps has been again and again shown to contain organic matter varying from 5 to 40 grains in the gallon, and yet Cholera has not occurred as the result of their use. In all cases where the pump has been shown to be the cause of disease, then it has been either demonstrated that the well has communicated with a cesspool or drain into which Cholera evacuations have passed, or the well has been placed in a situation in which such an occurrence might have taken place. The great case of the Broad Street Pump, in the parish of St. James's, Westminster, to the drinking of the water of which the outbreak of Cholera in that parish in 1854 was traced, is a capital instance in point. In that case the water was discovered to have been contaminated by the leakings of a cesspool connected with a house in which a fatal case of Cholera had occurred a few days before. The case also of the farmer and his family at Theidon-Bois, in Essex, is another, in which it was clearly demonstrated that the well which supplied the family with water was connected with a cesspool, the overflowings of which passed directly into the well, and eight persons out of a family of eleven thus met their death. The poison was conveyed to this house by the farmer himself, who had been in the South of England, where Cholera prevailed, and had returned home with the disease of which he eventually died. It is curious that this case should have in any way been connected with the outbreak in the East of London, but it was observed by Mr. Radcliffe, and afterwards referred to by the Registrar-General, that the Cobbin—a small stream which drains Epping in the neighbourhood of Theidon-Bois—actually flows into the Lea through Waltham Abbey. Whether the poison of the Epping cases could have got into the Lea and produced the poisoning of its waters or not, we are driven to the conclusion that the water supplied to the East End of London was one of the causes, if not the entire cause, of the great prevalence of Cholera in that district.

Another interesting point connected with the appearance of Cholera at the East End of London is the fact, that the attacks of the disease were actually limited to the districts supplied by the East London Water Company. Thus taking the district of Shoreditch, which lies to the north of the Great Eastern Railway, we find that the mortality from Cholera, although it is one of the poorest of the East End parishes, was only at the rate of 4 in the 1,000. Now, it is in this district that the East London Company's Works come in contact with those of the New River; and in five sub-districts out of seven, into which Shoreditch is divided for water-supply, the houses are supplied with water from the New River. All London is divided into thirty-seven water-supply districts. Six of these districts are supplied with water from the Old Ford Reservoirs of the East London Water Company, and in every one of these districts Cholera raged. The communities supplied by the other thirty-one districts have only suffered slightly from the disease, and in no one instance has the mortality been perceptibly increased, or of a character to lead to the supposition that it had been otherwise than imported from the Eastern districts; and it is quite impossible, we think, after the evidence produced, to come to any other conclusion than that the destruction of the 5,000 lives which were sacrificed to Cholera and Diarrhœa in the East End of London, during the months of July, August, September, and October, 1866, must be attributed to the nature of the water-supply.*

If the question be now asked whether there were any strongly *predisposing* causes existing among the population of the East End? we answer that up to the present time no prevailing predisposing cause has been demonstrated. It was not poverty, for the people of Bow and Poplar are wealthier than those of Bethnal Green, and yet they suffered most. It was not over-crowding, for the most over-crowded districts of Shoreditch escaped. It was not drunkenness, for drunkards who did not drink the tainted water escaped. It was not ignorance or vice, for the Medical Officer of Health for Bow, Mr. Ansell, and the Clerk of the Vestry of the same parish, Mr. Ceely, were both carried off at the commencement of the epidemic.

Seldom has the demonstration in the case of an epidemic been more complete, and never has a warning more solemn been given to local authorities of the duty they owe to their fellow-creatures. Had attention been paid to the admonitions which have been given in season and out of season by men of science, and Medical Officers of Health, water would not have been supplied for drinking purposes contaminated with the sewage of docks, canals, and foul streams. Had the Local Boards of Health heeded the warnings of those who saw the disease approaching their doors, they might have arrested it before it attained the severity of an unexampled plague. It is a still greater warning to our legislators. They have no excuse for the ignorance they betray of the advances of disease, and the causes of death in the community. It is our legislature that has thrown around the water companies of London the shield of protection. Whilst one of our water companies can boast that its original one-hundred pound shares are now worth twenty-three thousand pounds, our Parliament has steadily refused to allow further supplies to be introduced into London, and has opposed every attempt that has been made to procure for London a more constant and improved supply. Looking at these visitations of disease from the lowest point of view, their money loss, they are reproaches upon the economy and prudence of the

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* Since the above was in type I have seen a report by Dr. Letheby, in which he states as a reason for hesitating to accept the water supply as a cause of Cholera, that in two workhouses, one of which *was* supplied with East London water, there was no Cholera, and in another, which was *not* supplied with that water, there were twenty-seven cases of Cholera. Such exceptional cases as these might, no doubt, be explained by a careful investigation, and cannot be said under any circumstances to invalidate the overwhelming testimony of the connection of Cholera of 1866 with the East End water supply.

communities in which they occur. All that is sacred in the obligations of one man to another, all that is prudent in the economy of everyday life urges, upon our legislators, our corporations, and our people the necessity of an honest, energetic, and earnest determination, that the terrible blot of thousands being annually carried off by preventive diseases should no longer disgrace at once our boasted Christianity and civilization.

We have received a letter from Mr. George Greaves, M.R.C.S., an active sanitarian in Manchester, from which we publish (with his permission) the following extracts :—

"MANCHESTER, *Nov.* 23, 1866.

"Permit me to thank you for the very vigorous *exposé* of the sanitary abominations of Manchester made in the last number of your Journal. If anything would bring the Authorities to a sense of their duty, such writing would. But I fear the case is a hopeless one,* and that while the present *régime* lasts we must continue to breathe an atmosphere more or less loaded with the emanations from feculent matter, in various stages of decomposition. Thanks to our good water-supply—the one sanitary benefit conferred upon us by the Corporation—we have escaped Cholera. This fact was cited by the Town-Clerk at one of the meetings of the recent Social Science Congress, to prove that our midden-system is not injurious to health. It would almost have been better for us, in the end, if we had had a smart epidemic of Cholera. The deaths from Fever (chiefly Typhus) have in the two last weeks been 20 and 22, and our death-rate last week was one death higher than that of Liverpool."

These statements afford striking confirmation of the views expressed by the author of the above article; and moreover, we suspect that if the cause of the Cholera outbreak in Liverpool could be traced, it would be found to be in some way connected with the water-supply. That has been (until the recent floods) notoriously deficient, and in a Report published by Mr. Duncan, the Liverpool Water Engineer, in July last, about the time of the outbreak of Cholera, he said: "The Committee are aware that the water now at command is insufficient to admit of its being kept constantly on. Thirty gallons per person per day are not considered more than enough for each person, of the entire population. At the present time we are short of that quantity by about 33 per cent.; and I may add that, on a very recent occasion, evidence was given by an authority to the effect that to the scarcity of water have been traced demoralization, disease, and death."

In the same Report, he says of three wells, two of which are situated in the town (Water Street, Hotham Street, and Soho): "The waters of these wells are hard, inferior in quality, costly in obtaining, compared with those of others, and would not be used, did not necessity compel."

During the existence of Cholera, suspicion fell upon those wells. They were permanently closed, and when it was attempted to raise a discussion on the cause of their discontinuance, silence was the order of the day; but recently again there was a Report from Mr. Duncan, published in November, in which he says of those wells: "1st. As regards Hotham Street . . . the water is not good, and costly to obtain. It is situated in a densely-populated district, *where no well can be insured against pollution.*" . . . "As regards Soho Well . . . the water inferior, costly, and objectionable." . . . Water Street Well appears to be still used.

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* Mr. Greaves does not refer to Salford.

We make these observations with a view to add further evidence to that cited by Dr. Lankester, not at all to draw invidious comparisons. The Liverpool Water Authorities deserve well of the town, and they merit (what up to the time these remarks are written they have not received) the support of the Council, in their endeavours to extricate Liverpool from a grave difficulty by providing the town with a large and constant water-supply.

We would, however, draw the attention of Mr. Greaves, as well as that of the author of the foregoing article, to the 49th Section of the Sanitary Act of 1866, and would ask them, whether, with their strong conviction of the danger to which the inhabitants of their respective cities are exposed through the neglect of the Local Authorities, it would not be desirable that they should induce their townsmen to bring the facts stated by them under the notice of the Home Secretary. An inquiry was lately held in Liverpool in connection with a similar grievance to that complained of by Mr. Greaves—namely, the manure wharves within the borough, and after an impartial hearing before Mr. A. Taylor (whose industry and demeanour cannot be too highly lauded) an official intimation was sent down to Liverpool from the Home Office politely limiting the time for the discontinuance of the wharves in the towns.

If the Home Secretary be firm, and insist upon compliance with his courteously-worded request, he will deserve great praise for having broken the ice, in putting the Act into operation; and it will no doubt be gratifying to Mr. Bruce, M.P., the framer of the Act, to find it so soon carried out.

The influence of this decision will be felt in every town where such abominations exist.

THE EDITORS.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

The Cattle Plague has at length dwindled to altogether insignificant proportions. The number of cases reported weekly is rarely more than 10; and an occasional aggravation of the disease, or its reappearance now and then in old localities, raising the weekly total to 20 or 30, while it no doubt shows what a malignant disorder we still retain among us, may, we hope, be taken to be merely the occasional flare of an expiring flame. How much we owe to the policy of extermination, rather than attempted cure, may be seen by the results of the opposite system, as witnessed both in Holland and among ourselves. In the annual address, recently given by the President of the Royal Agricultural Society, it was pointed out that the number of cases reported in two weeks—the one in September, 1865, and the other in September, 1866, was exactly the same. Unrestricted cattle traffic during the two months following the former period, had swelled the tale of cases up to thousands. Destruction of affected stock and absolute isolation of infected places during the two months following the corresponding week of 1866, had reduced the disease almost to extinction. In Holland again, during the past summer, when here the disease was yielding to restrictive measures, it grew to lamentable proportions—rising from two or three hundred cases weekly during June, to nearly eight times as many in September. There is certainly sufficient guidance for us here as to the policy to be followed if the disease should reappear among us in anything like its original severity. Up to the present time about 5¼ per cent. of the whole cattle stock of Great Britain have been attacked, while of the whole stock upon infected farms, nearly 60 per cent. took the disease. Of the total number of attacks whose results were known, 35 per cent. were killed; 51¼ per cent. died; and 13¾ per cent. recovered.

The utilization of Town Sewage was the subject of a conference at Leamington during October, which was attended by a number of gentlemen interested in the solution of the difficulties surrounding the subject. These difficulties are almost entirely the result of an extension of the water-closet system, by which the waste of houses, no longer received into cesspools and carted away to market-gardens, is washed into culverts, and thence pollutes our rivers. The remedy offered by one party to this discussion is the irrigation of grass lands with the drainage water, which thus becomes clarified before reaching the river, and yields a valuable produce during the process. The other plan consists in the substitution of earth-closets for water-closets in our houses. It only needs that a storage of dry earth be provided for use in this way, and occasionally replenished; that the prejudices of servants be removed or overruled; and that frequent removals of the boxes be provided for. A well-arranged system of scavenging would then be easily carried out with perfect inoffensiveness, both in the house and out; and we should have a most valuable manure, which might be carried, load by load, to farms all round our towns, where loads of top soil for similar use would be readily obtained in exchange for it, the difference in value being paid. The difficulty of displacing the existing system would, however, be very great; and, committed as we are by an enormous expenditure to the plan of keeping our towns clean by washing into drains, it is not at all likely that the earth-closet system will be adopted, except in detached houses or small villages. Meanwhile, at Croydon, at Barking, Rugby, and elsewhere, evidence is accumulating that the irrigation of grass lands with filthy sewage water, is both a perfectly inoffensive and a profitable process.

A meeting of gentlemen interested in the Utilization of Sewage was held in Liverpool in December, and owing probably to the presence of Lord Robert Montagu, who delivered an admirable address on the subject, the attendance was very numerous, and included the *élite* of the town and neighbourhood. There the advocates of the Earth-Closet were in a decided minority, for the reasons stated—*viz.* that the system is not suitable for large towns, where the quantity of earth to be carted would be enormous, and because arrangements have already been entered into between the Liverpool Corporation and the Sewage Company, which promoted the meeting, for the utilization of all the sewage of the town.

Most of the statements made by Lord Robert Montagu were repetitions of what is already known to agriculturists, and has been announced from time to time in these pages, but it may be of interest to our readers to know that in Liverpool it is intended to intercept the sewage at the outfall of the sewers, and at first to experiment with it upon the sandy soil skirting the Lancashire and Yorkshire line from Liverpool to Southport. There is a large tract of country all about the north side of Liverpool, which is at present a mere sandy waste, but no doubt the application of sewage water will render it fertile and suitable for the growth of rye-grass, and if the promoters of this sewage scheme can at the same time fertilize waste land, and render the most unhealthy town in England more healthy, they will confer a double favour upon society. They have our very best wishes for their success.

Professor Voelcker has lately given a lecture on the application of manures before the London Farmers' Club, which is a remarkable illustration of the progress made towards a satisfactory relationship between scientific teaching and farm practice. Instead of treating vegetable growth as a purely chemical phenomenon; or supposing, as lecturers on agricultural chemistry seemed formerly to do, that it only needs the supply of elements in manure to ensure a corresponding assimilation of them by the growing plant, we now learn from the chemist what we already knew by experience, that luxuriance of growth and abundance of produce depend as much upon the mere question of even and uniform distribution of food for plants—as much in fact upon its accessibility—as upon the increase of its supply. We are told, for example, that an inferior guano well powdered and mingled with a sufficient quantity of diluent material so as to ensure its even distribution through the land, may be a greater help to the fertility of the soil and a greater fertilizer of the current crop than a better guano imperfectly applied. It is a truth of the same kind, which Dr. Voelcker also told us, that no manure at all upon a stiff clay land well tilled will tend to its fertility rather than a heavy dressing of farm dung applied when the land is soft and liable to be poached by the horses and carts employed in putting it on.

The application of farm manure as a top dressing in dry weather is now confidently advocated—even though a scorching sun and driving winds should cause the separation of all evaporable matter from it. There is no loss of ammonia during the putrefaction of farm dung. The loss which it suffers during that process is due to the washing of soluble salts out of it by rain. And if the dung be spread at once upon the land, all its valuable constituents will find their way into the soil.

Among the other topics which have occupied the agricultural world during the past quarter, is the growing organization of tenant farmers in Chambers of Agriculture, through which their voice may be heard in public discussions, and through which their views may be influentially urged on Government. We must also refer to the attempt of the Royal Agricultural Society to promote agricultural education by the addition of their prizes to the list of distinctions offered for competition before the University examiners of middle-class schools. And lastly, we may mention that, moved by the disasters of the past harvest season, the Society of Arts is about to offer a prize for any contrivance or machine which shall artificially accomplish or facilitate the drying process on which our hay and corn harvests depend for the quality of their produce.

2. ARCHÆOLOGY AND ETHNOLOGY.

THIS Chronicle bears a heading new to the 'Quarterly Journal of Science,' and it may therefore be as well to define at the outset the subjects which we shall attempt to represent in it. Of late years Archæology has dived deeply into the records of our race, bringing to the surface many facts and inferences, which throw light on the most recent portions of Geological History. Ethnology also has made rapid progress, and, from having been a mere catalogue of the characters of the several varieties of one Natural History species, has come to possess a wider scope and a higher aim. Archæology and Ethnology thus shade off, on the one hand, into Geology and Zoology, and on the other, into Modern History and Politics. It is in their former relation only that we shall in this Chronicle discuss their progress, as in this respect only do they concern the student of Natural Science.

We cannot do better than begin our new Chronicle with an account of the great work, entitled 'Reliquiæ Aquitanicæ,'* commenced by the late Mr. Henry Christy, F.R.S., and M. E. Lartêt, and continued by the latter with the assistance of some of the best antiquaries, including Mr. John Evans, Mr. A. W. Franks, and Mr. W. Tipping; it is published at the expense of Mr. Christy's executors, and is edited by Professor T. Rupert Jones. Three parts have now appeared, illustrated by numerous plates and woodcuts; but there does not seem to be any systematic arrangement, the different objects appearing to have been figured and described as convenience, rather than a system, required. The results, however, are sufficiently interesting now, and will probably be made much more so by the inferences which will hereafter be drawn from their consideration by the experienced savans concerned in the publication of the work.

In the Dordogne district the sides of the valley of the Vézère, and of the gorges of its tributary streams, rise in great escarpments, crowned with projecting cornices, below which are seen horizontal niches or hollow flutings; in these cliffs occur also numerous caves and rock-shelters either at the level of the floods of the present day, or higher up, thus showing that no alteration in the level of the district has taken place since their formation. These cavities are for the most part mere shelters, so we must suppose that when they were inhabited by man, as they no doubt were at a remote period, a protection was erected outside them, or that the people using them were extremely uncivilized. Indeed it is evident that they were used chiefly as fireplaces, for hearth-stuff is abundantly found in most of them; and it is curious to observe that at the present day the cottages of the district are built in precisely similar positions, the fireplaces being situated in the face of the rock. The hearth-stuff has yielded a mine of organic wealth in the shape of remains of animals, which had been killed for food, consisting chiefly of the reindeer, the horse, and the ox, with the ibex and the chamois. The "wild boar was scarce or but little eaten," and with the exception of the horse the fauna tends to a northern grouping. The rock-dwellers were not unaccustomed to more delicate food, as is proved by "the many bones of birds and of salmon which are mixed with the refuse;" they also seem to have been very fond of marrow, as the marrow-bones have invariably been split for the purpose of extracting it. The question whether the rock-dwellers cooked their food is at present unsettled. The bones do not show traces of the action of fire, so that the meat could not have been roasted; and there is not sufficient depth of earth below the hearths to encourage the supposition that it was cooked by being buried in the earth, and having a fire lighted over it. Thus there remains but one method possible—boiling: that these people boiled water is certain because the "boiling-stones" have been found, and they have evidently been heated for the purpose; but no pottery is forthcoming, so the water was probably boiled in hollows in the rock. The climate of the country at the time when the rock-dwellers peopled it, was, as already indicated by the fauna, very much colder than it is now; but another argument has been very ingeniously used by the authors, namely, that in the South of France at the present day such masses of animal remains as we find in the caves, would speedily become a fearfully decomposing mass; besides which the rock-dwellers have "almost invariably chosen a southern exposure, and the warmest and sunniest nooks for their residences." The causes of this colder climate have not yet been entered upon: but as there has been little or no change of level, and there are no high mountains in the vicinity, it will certainly be a puzzle. The implements and the fauna point to a much later period than that usually denominated "Glacial," so it is unlikely that the cause was cosmical; and it is difficult to conceive what local changes in the character of the surface would have so great an effect.

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* 'Reliquiæ Aquitanicæ. Being Contributions to the Archæology and Palæontology of Perigord and the Adjoining Provinces of Southern France.' By Edward Lartêt and Henry Christy. London: Baillière.

The implements found in the caves and rock-shelters are wonderfully interesting, and, fortunately for antiquaries, are illustrated with the most prodigal liberality. A comparison of them with recent implements in use amongst uncivilized peoples points in the same direction as the fauna, namely, northwards. The implements are either of flint, bone, or deerhorn, and comprise almost every conceivable variety; in flint "from lance-heads long enough and stout enough to have been used against the largest animals, down to lancets no larger than the blade of a penknife, and piercing instruments of the size of the smallest bodkin;" and in horn or bone every variety of chisel, awl, harpoon, and arrow, with, lastly, "eyed needles of compact bone, finely pointed, polished, and drilled, with round eyes so small and regular," that it requires experiment to prove that they could have been drilled with stone. Although we have dwelt too long on this most interesting publication in its unfinished state, we must just mention that it shows already that in these caves the works of art were discovered which have already been noticed and figured in this Journal.* MM. Lartêt and Christy have, indeed, proved that, so far as we know, France was the birth-place of the Fine Arts, the Dordogne Caves having furnished evidence of the cultivation by the rock-dwellers of Music, Painting, and Sculpture, Music being represented by whistles made out of the phalangeal bones of the reindeer or chamois; Sculpture by an ornamented poniard-handle and many similar examples, figured as before cited; and Painting by the traditional red-ochre paint of the savage.

Dr. Ferdinand Keller's 'Lake-dwellings of Switzerland and other parts of Europe,'† which has been translated and arranged by Mr. J. E. Lee, is a work of hardly less interest, and claims also a special notice at our hands. The lake-dwellings consist of pile-dwellings, fascine-dwellings, and crannoges. The pile-dwellings were thus built: piles having been driven into the bed of the lake, their heads were brought to a level and connected by platform-beams, fastened either by wooden pins or by means of mortises or central hollows in the heads of the vertical piles; and the hold of the piles in the bed of the lake was in some cases further strengthened by large quantities of stones being brought in boats and sunk around them.

The fascine-dwellings have a very peculiarly constructed foundation, which was composed of horizontal layers of twigs instead of vertical piles; but a few of the latter were also used as stays or guides for the great mass of sticks. These fascine-dwellings are to some extent of similar construction to the crannoges, which consist of the following portions: (1.) an outer rim, or stockade of piles or boards, enclosing either a circular or oval space, the lowest bed within which is made up of "a mass of ferns, branches, and other vegetable matter, generally covered over with a layer of round logs, cut into lengths of from four to six feet, over which is usually found a quantity of clay, gravel, and stones."

Such are the varieties of substructure of the lake-dwellings; but of the superstructure very little is known, except that the huts were rectangular, and that each one was provided with a hearth consisting of three or four large slabs of stone. There are some peculiarities in the distribution of these dwellings which deserve notice; for instance, fascine-dwellings "occur chiefly in the smaller lakes, and apparently belong to the Stone age," while many of the pile-dwellings have been inhabited in the Stone, Bronze, and Iron ages. Crannoges have been found chiefly, if not entirely, in Ireland and Scotland, and they appear to have been chieftains' forts, and fastnesses for occasional retreat, while the Swiss lake-dwellings were places of permanent habitation for families and tribes. The latter were placed at a greater or less distance from the shore, and their site appears to have been determined by such circumstances as would be appreciated by people enjoying a peaceful existence, "as even the earliest settlers were not only fishermen and hunters, but also shepherds and agriculturists." It also appears that they were traders, even in the Stone age, for such a material as nephrite could only have been obtained by barter, as it does not occur in Europe; while in later times they must have procured iron by the same means. They apparently clothed themselves with hides and skins, as well as with plaited and woven flax, and it seems probable that they had a religion, for Dr. Keller infers certain figures of the crescent moon to have been objects of worship from the earliest period. We have no space to trace the advance of civilization amongst the lake-dwellers during the supposed successive periods of Stone, Bronze, and Iron; but we have said enough to draw attention to the subject, which is illustrated with extraordinary completeness by the discoveries described in Dr. Keller's work, and we therefore leave it, with the question of the existence of the lake-dwellings so late as the Gallo-Roman period, to be discussed by the antiquary and the ethnologist.

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* No. III., July, 1864, pp. 578–582.

† 'The Lake Dwellings of Switzerland and Other Parts of Europe.' By Ferdinand Keller, President of the Antiquarian Association of Zurich. Translated by J. E. Lee, F.S.A., F.G.S. Longmans.

The Crannoges of Ireland and Scotland were built on shallows or islands, and, as already remarked, appear to have been places of retreat, thus indicating a great contrast in the habits of these people from those of the Swiss lake-dwellers.

Dr. Keller is of opinion "that the different settlements in what are called the Stone, the Bronze, and the Iron ages do not indicate a succession of races, or the destruction of one people by another, but merely different grades of civilization amongst one and the same people," and that the lake-dwellers belonged to the same people as their contemporaries on the mainland. He also accepts the conclusion that certain bronze objects of a peculiar form and ornamentation, such as some of those found in the settlements on the land and in the lakes, are referable to the Celts; and as history makes no mention of any early people but the Celts, who received their civilization in later times from the Romans, he infers "that it would be contrary to all the facts adduced to arrive at any conclusion but this:—that the builders of the lake-dwellings were a branch of the Celtic population of Switzerland, but that the earlier settlements belong to the prehistoric period, and had already fallen into decay before the Celts took their place in the history of Europe."

Mr. Laing's book on the "Prehistoric Remains of Caithness,"* has been received with small favour by the antiquaries of that county, and his conclusion that the human remains found by him in certain kists and mounds belong to the Early Stone-period, has excited a rather warm controversy; while his assertion that the Caithness people of that time were addicted to cannibalism, has been indignantly repudiated by every patriotic Scot. The last two numbers of the 'Anthropological Review' contain several papers by Messrs. Anderson, Shearer, Cleghorn, Petrie, and Dr Hunt, in which Mr. Laing's statements and inferences are severely criticized, and the opinion of these authors seems to be that the remains are very recent, probably not more than three or four centuries old. The principal series of graves are said to be the burial places of shipwrecked seamen, and to occur in a raised beach, not in an artificial mound. That some stone implements have been found is admitted, but they do not seem to have been in any case discovered by the explorers themselves; but even if their authenticity is hereafter proved, as Mr. Shearer remarks, "the whole thing is now so mixed up together as to render any of the things in a scientific inquiry utterly useless." Mr. Laing is thus charged by these authors with having made a most extraordinary series of blunders, and to have been rather careless of ensuring the authenticity and isolation of specimens from different localities and of different ages.

The Congress of the Archæological Institute, held in London during the past summer, deserves notice here chiefly on account of the luminous address delivered on the occasion by Sir John Lubbock,† in which that zealous ethnologist, antiquary, and zoologist, sketched out the present condition of that portion of archæological science which relates to what he terms the "Primeval Period," chiefly with a view of showing that the method hitherto employed almost entirely in geology and zoology had been applied to archæology with the same success as had attended its use in the former branches of knowledge. By the term "Primeval Period," Sir John indicated that extending from the first appearance of man down to the commencement of the Christian era, and to this range of time he confined his observations. The period has been divided into four epochs, namely, (1) the Palæolithic or First Stone-age; (2) the Neolithic or Second Stone-age; (3) the Bronze-age; and (4) the Iron-age; so we cannot do better than consider their distinctive characters *seriatim*.

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* 'The Prehistoric Remains of Caithness.' By Samuel Laing, Esq., M.P., F.G.S. With Notes on the Human Remains, by Thomas H. Huxley, F.R.S. Williams & Norgate.

† Our notice of this Address is based on the Report of it which appeared in the 'Athenæum' for July 21st, 1866.

The Palæolithic age is the most ancient period in which we have any proofs of the existence of man, although there are faint indications of his presence in still earlier times. The antiquities belonging to this epoch are those which, occurring in beds of gravel and loess, as well as in caves, associated with the remains of extinct animals, have received so much attention from geologists and antiquaries during the last few years. The climate of Western Europe during this period was much colder than it is now, and the inhabitants used rude implements of stone (flint chiefly), which were not polished, and some types of which differ remarkably from any of those of later date; they were ignorant of pottery and of metals, as also are many races of savages at the present day.

During the Neolithic age in Europe polished stone axes and hand-made pottery were extensively used, long before the discovery or introduction of metals. To this period belong the Danish kjökkenmöddings, many of the Swiss lake-dwellings, and several of the tumuli or burial-mounds; but the objects referable to it do not occur in river-gravels. Domestic animals were reared, and agricultural pursuits were followed by the Neolithic people, who belonged, apparently, to at least two distinct races, as in the tumuli two forms of skull have been found—one long and the other round.

Implements of stone remained in use during the Bronze age, and those of bronze were chiefly copies of the former; the pottery was much better than that of the Neolithic age; and although much of it was still hand-made, some is said to show marks of the potter's wheel. Gold, amber, and glass were used for ornamental purposes; but silver, zinc, lead, and iron were apparently unknown, as well as coins and writing.

During the Iron age the metal which gives its name to the period was first used for weapons and cutting instruments, and here, Sir John Lubbock remarks, "we emerge into the broad and, in many respects, delusive glare of history." With the exception of the use of iron, the differences between the implements of this period and those of the Bronze age are mostly relative; *e. g.* "the objects which accompany bronze weapons are much more archaic than those which are found with weapons of iron." This fact, and "the frequent occurrence of iron blades with bronze handles, and the entire absence of the reverse," are sufficient to show that the use of iron must have succeeded and replaced that of bronze. Another fact of interest is, that the bronze associated with iron frequently contains lead and zinc in considerable quantities. Besides these characteristics, we may mention that silver was used for ornaments, and that inscriptions of the Iron age have been discovered in more than one locality.

The foregoing is a mere outline, more or less indefinite, of the characteristics of these four epochs, as described by Sir John Lubbock; we have already filled in some of the details for the earlier ages in noticing the works of Messrs. Christy and Lartêt, and of Dr. Keller; but with respect to the later periods, we hope to have an apportunity of saying something more on a future occasion.

3. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

SINCE our last Chronicle was in type, we have heard, with regret, of the death of Hermann Goldschmidt, the astronomer. The loss to science is a serious one. Originally intended to succeed his father as a merchant, Goldschmidt at the age of thirty commenced the study of painting. He pursued this art successfully for fifteen years, and was already forty-five years old when he turned his attention to astronomical observation. He devoted himself with such success to this new pursuit, that in the course of nine years he added thirteen new asteroids to the solar system, discovered many variable stars, and determined the places of 3,000 stars not marked in the charts published by the Academy of Berlin. It is to be noted, for the encouragement of amateurs, that the instruments used by Goldschmidt in effecting this important series of labours were of very moderate dimensions. We believe his most powerful instrument was a five-foot achromatic mounted on a movable tripod stand.

The Padre Secchi at Rome has attacked the spectrum-analysis of stars with considerable success. Before presenting the results attained by him, however, we must premise that interesting as they are, the method of observation does not seem comparable for accuracy to that pursued by Mr. Huggins and Professor Miller.

The spectrometer used by Secchi consists of a cylindrical lens (focal length, three inches) placed in front of and near the eye-piece. Beyond the lens is placed a prism of Amici, in which the deviation is *nil*. He recommends this arrangement as powerful, and also as cheaply applicable to amateurs' telescopes.

Secchi applies the following method of comparison:—the spectrometer being so placed that the lines in the spectrum are parallel to the celestial equator (that is, to the direction of the star's apparent motion) a known or comparison-star is brought on to one of the threads of the finder; returning then to the large telescope the observer brings one of the points of the micrometer behind one of the principal lines of the star's spectrum. The star to be compared with the first is then brought under the same thread of the finder. If then the micrometer point coincides with a line of the spectrum, this line and the line of the first star's spectrum are evidently identical.

One of the most remarkable results (assuming its correctness) of Secchi's researches, is the observation that two stars—γ Cassiopeiæ, and β Lyræ—show *bright* lines. In γ Cassiopeiæ, for instance, there are several bright lines, but one dominant line in the blue-green, taking the place of a dark line—the well-known line F of hydrogen—in other star-spectra. The spectra of these two stars are compared by Secchi with the continuous spectrum crossed by bright lines given by magnesium.

The observation would seem to indicate that some stars owe their light in part to the luminosity of their gaseous envelopes, and notably to the presence of burning hydrogen.

Before leaving the subject of spectrum-analysis, we must note the investigation by M. Jansen, of Paris, of the formation of dark lines when light passes through aqueous vapour. He has ascertained that the intensity of certain lines seen in the solar spectrum varies with the amount of moisture present in the atmosphere. By transmitting the light of sixteen gas-burners through a tube filled with steam he reproduced all these lines. Father Secchi appears to have anticipated this discovery.

M. Chacornac has published an interesting paper on Comets. Space will not permit us to deal with the subject otherwise than briefly. He compares together the atmospheres of the sun, of planets, and of comets, under the several conditions of temperature and attraction to which those atmospheres are subject. In the case of planets it is possible that there should be an equilibrium between the attractive force of the planet on the external layers of the atmosphere, and the elastic forces of the layers below; in such a case the atmosphere will have a definite limit. But this clearly cannot be the state of the atmospheres of comets near perihelion, nor of the solar atmosphere. Beyond the bounds of the solar attraction the forces of dilatation exhibit themselves as projective forces acting outwards from the solar periphery. The rays of the solar aureole, in total eclipses of the sun, indicate, by their configuration, the expansive force of gases violently projected into planetary space. To a similar expansive action, acting upon cometary atmospheres, the formation of cometary aigrettes is attributed, while the formation of comets' tails is ascribed to repulsion, produced by the expansive forces of the solar atmosphere.

M. Léon Foucault has devised a new method of solar observation. This consists in covering an achromatic object-glass with a thin film of silver. Such a film, he finds, does not interfere with the definition of the sun. The rays from the less refrangible end of the spectrum are stopped, while the others suffice to exhibit the solar features. M. Leverrier pronounces very favourably on this arrangement, which "*seems* to promise," he says, more distinct views of the sun than have hitherto been obtained. Other observers find the details of the solar disc slightly "veiled" when thus viewed. It appears to us that there are several objections to the new method, and we should not recommend amateurs to have a valuable object-glass silvered, until something more is heard as to the possibility of restoring the glass to its original state.

But we hear of a contrivance by Messrs. G. and S. Merz of Munich, which seems to promise better views of the sun than have ever yet been obtained. In their solar eye-piece, two pairs of plane unsilvered glass mirrors are so placed, that, by rotating one pair, any part whatever of the sun's light may be intercepted. By this arrangement no false colour is introduced, as with blue, or neutral-tint glasses. Father Secchi says that films are seen with a frosy tint (the colour of the protuberances seen in solar eclipses), in the new ocular, which appeared blue in the common oculars.

The display of meteors (or Humboldt's star-shower, as some name the phenomenon) fully equalled the expectations of the most sanguine. Mr. Dawes considers that upwards of 3,500 fell before 2h. 15m., on the morning of November 14th. Mr. Talmage noted the following numbers in successive intervals of five minutes from 12h. 52m. to 2h. 12m.:—115, 125, 231, 324, 239, 214, 147, 104, 109, 57, 56, 31, 22, 28, 37, 20; showing that the maximum intensity of the shower occurred at about a quarter-past one. While Mr. Hind and M. Du Chaillu (who assisted him) note that "few of the meteors were remarkable for brilliancy or persistence of the trains," Mr. Harris, of Southern-hay, near Exeter, remarks, that at 1h. 15m. a very bright meteor burst, causing a light *as bright as daylight*, leaving a train which lasted *for a quarter of an hour.* This is probably the same meteor that is described by Mr. Heath as passing through the Pleiades at 1.30 A.M., and leaving a trail which did not disappear for four minutes. A more satisfactory observation of this "bright, particular star," is that made by Capt. Noble, the astronomer. He notes it as "a splendid one," hour 13h. 20m. 10s. (that is, 1h. 20m.) S.W. of Pleiades, leaving a train which lasted upwards of five minutes by the Observatory clock, and which gradually contracted into a fusiform mass (like 31 M. Andromedæ), then into an amorphous one, and finally disappeared behind a cloud. Some of these more permanent streaks, observed in the telescope, were found to be in focus with the stars, indicating a distance of at least 40 or 50 miles. This observation is due to Mr. Bird, of Birmingham.

While on the subject of meteorites, we may note that the French Academy has received an intimation from Marshal Vaillant, that Marshal Bazaine has found an aerolite in Mexico weighing no less than 860 kilogrammes (considerably more than three-quarters of a ton!)

In the '*Astronomische Nachrichten*' (No. 1,606) is an account from C. Behrmann, of Göttingen, of shooting stars coming out of a thick cloud, about 15° from the horizon. The cloud, which covered the sky, was so dense that meteors could not have been seen through it. He considers, therefore, that the stars were driven through the cloud, and came within one-tenth of a mile from the earth. It appears to us that we have read of phenomena strikingly resembling those described by M. Behrmann,—in Arago's Meteorological Essays, under the head 'globular *lightnings*.'

The planet Mars will be in opposition on January 10th, 1867, and though less favourably situated as respects distance than in November and December, 1864, or October, 1862, will be well worth careful study. In fact, the presentation of Mars, and the phenomena exhibited upon his surface, vary considerably from opposition to opposition; the complete study of the planet requires that he should be observed at oppositions occurring all round the ecliptic. As respects the oppositions of 1862 and 1864, we refer our readers to Professor Phillips's graphic paper in our volume for 1865. In the approaching opposition the Polar presentation of the planet (as seen in an inverting telescope) will be that shown in Fig. 1.

FIG. 1

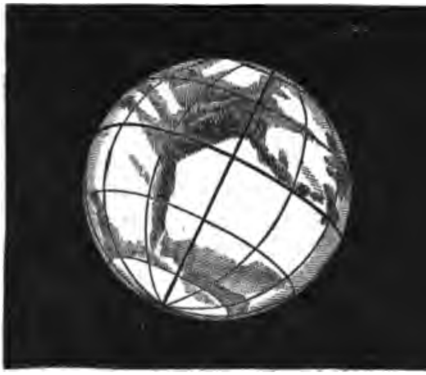
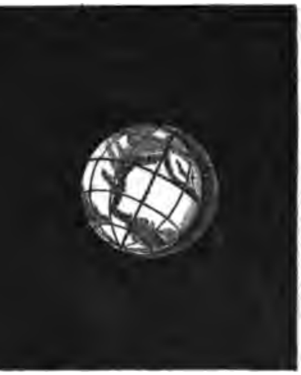


FIG. 2



The outlines of continents and seas here marked in are obtained from the map accompanying the above-named article. By tracing (from Fig. 1) a series of meridian outlines, and filling in from Professor Phillips' map, our astronomical readers will be enabled to obtain views of the planet at successive intervals of two (Martial) hours. Such views would suffice for comparison with any telescopic views taken near the time of southing,* or with views taken at any hour, if due regard be paid to the varying *slope* of the planet's axis. Towards the end of February the planet (now become much smaller) will appear perceptibly gibbous; his maximum stage of gibbosity, attained early in April, and his apparent disc at that time are exhibited in Fig. 2.

Owing, apparently, to a change of authorities, the apparent diameter assigned to the planet in the 'Nautical Almanac' is larger for January 10, 1867, than for December 1st, 1864. Observers, however, must not expect to find the planet larger; in fact, he will be more than 9,000,000 miles farther from the earth on January 10th, than when in opposition in 1864.

Two more minor planets, the 90th and 91st, have been discovered: the first by Dr. Luther, of Bilk, near Düsseldorf, on October 1st; the second at the Marseilles observatory.

On the 6th of March there will be an annular eclipse of the sun, visible throughout England as a partial eclipse. It will begin at Greenwich at 8h. 17m. A.M., and reach its greatest phase at 9h. 32m. A.M., and end at 10h. 52m. A.M. About seven-tenths of the sun's diameter will be obscured at the time of the greatest phase.

We call the special attention of our readers to the obscuration of the Lunar Crater *Linné* (on the *Mare Serenitatis*) observed by Herr Schmidt at Athens. The epoch at which the crater again becomes visible should be carefully noted. This is the same crater that Schröter saw transformed into a *dark spot* on November 5th, 1788.

PROCEEDINGS OF THE ROYAL ASTRONOMICAL SOCIETY.

Professor Kaiser, of Leyden, in a letter to the Astronomer-Royal, discusses the qualities of the latter's double image micrometer. He expresses a favourable opinion on the instrument, but in one respect astronomers will be disappointed. It has long been known that measurements effected by the best observers with the wire-micrometer present considerable discrepancies. Now, if it had resulted from Professor Kaiser's experiments that the instrument was in fault in such cases, there would have been a prospect of remedying the evil. It appears, however, that the same observer using both the wire-micrometer and the double-image micrometer in delicate measurements, obtains results appreciably coincident; so that, as Professor Kaiser remarks, "the discrepancies are far more to be sought in the observers than in the instruments." Referring specially to double-star measurements, he remarks further, that they appear "far too inaccurate for the consequences one will derive from them." The Professor's list of observations serves to exhibit the close approach to coincidence attained by the use of the two instruments, and to afford to observers new estimates of some favourite test-objects.

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* The horizontal line through the centre represents the *true path* of the planet; at the moment of "southing" the slope of the axis will be a few degrees less than in Fig. 1, since the planet's motion in opposition will be carrying him slightly northwards.

General Shortrede discusses the effect of the vapour of mercury in depressing the thermometric column. In temperate climates this effect is not often appreciable, and except in very delicate experiments may perhaps be safely disregarded; but in the tropics, or in exceptionally warm weather, the height of the mercurial column is very sensibly depressed from this cause. In India, for instance, General Shortrede found that the true reading, obtained after tilting the barometer so as to condense the vapour, differed from the observed reading before that operation by from 10 to 20-thousandths of an inch, and on one occasion by so much as ·023. The tubes were in exceptionally good order, one having been boiled more than twenty times, the vacuum being so perfect that after the tube had been placed some hours in a horizontal position "the mercury, by electrical attraction, would adhere to the top of the tube, and not separate till shaken by tapping,"—the tube of 32 in. remaining full in this way, at Pana, where the average height is 28 in.!

The subject seems worthy of investigation, since if we would learn the laws regulating the variations of atmospheric pressure, the minutest circumstances affecting the truth of barometric indications must be recognized, so as to be either eliminated or corrected. The Greenwich photographic registrations are evidently liable to be peculiarly affected by a cause of this kind. General Shortrede noticed, indeed, that on one warm day of the past summer the vacuum of the barometer for outside indications (at Greenwich) was studded with minute globules of mercury, derived from the condensation of the mercurial vapour.

Father Secchi sends a drawing of the spectrum of Antares (the Sirius of red stars). Antares attains a sufficient elevation in the latitude of Rome for satisfactory observation with the spectrometer. As might be expected the spectrum (which, by the way, is presented in a reversed position) exhibits a crowding of lines towards the more refrangible (or violet) end, and several spaces clear of lines, or in which lines are more sparsely strewn, towards the red end.

Captain Noble remarks that Jupiter's third satellite reappeared two minutes before the time predicted in the Nautical Almanac.

The error is, of course, due to a misprint; but the circumstance is noteworthy, as showing the confidence with which astronomers are in the habit of accepting a series of predictions crowded together in a thick octavo volume, published three or four years before the predicted events happen. The non-astronomical world are astonished when the few events which admit of general observation happen as predicted; but it is a source of far greater astonishment to the astronomer that a single telescopic phenomenon out of many thousands predicted should occur a few seconds before or after the predicted time.

In the *Comptes Rendus* of July 30, and August 6, 1866, there is an interesting paper by M. Faye on variable stars. He sums up the results of his examination of recorded phenomena as follows:—

"So-called new stars are not really new, their all but sudden apparition being only an exaggeration of the ordinary phenomenon of periodical variables, a phenomenon corresponding (in turn) to simple oscillations, more or less sensible, in the phenomenon of the production and maintenance of the photospheres of all stars. These phenomena, considered as successive when the history of a star is examined in part, characterize the progress of the cooling of the star, and the decline of its solar or photospheric phase. When these phenomena occur thus in an irregularly intermittent manner, with very long and gradually increasing intervals, they are the precursors of the star's extinction, or at any rate of the formation of a first crust more or less consistent. Hence it is that phenomena of this sort take place only in stars already very faint, and never result in the formation of a fine new star."

Our space will not permit us to deal at length with the papers read and discussed at the November meeting of the Astronomical Society. The remarks in which the President claimed for astronomy the credit of recovering the Atlantic Cable are noteworthy. The connection between the price of Atlantic Telegraph shares and the transit-tube at Greenwich, seems at first sight as far-fetched (and is in reality as just), as that traced by a French astronomer between the cotton trade and Jupiter's satellites.

A paper by Mr. Lynn, "On the mass of Jupiter, as deduced by Herr Krüger from observations of Themis," deals with an important subject. The determination by Pound in the 17th century had for a long time been adopted as the true value, though no account remained of the observations made by Pound beyond the mere statement of the numbers in Newton's 'Principia' (lib. iii., prop. viii., cor. i.). The mass thus assigned was $\frac{1}{1067}$th of the sun's mass. But about the year 1826, Nicola calculated a larger value $\left(\frac{1}{1053\cdot924}\right)$ by means of the perturbations of Juno; Encke from the perturbations of Vesta found the value $\frac{1}{1050}$, and from the perturbations of the comet bearing his name, $\frac{1}{1054}$. Gauss confirmed these results by observations of Pallas. Airy, returning to the satellites, obtained the value $\frac{1}{1046 \cdot 77}$ in 1837; a result confirmed by Bessel's determination, $\frac{1}{1047 \cdot 87}$, and by Captain Jacob's estimate, $\frac{1}{1047 \cdot 54}$—both these results being also deduced from observations of the satellites. Herr Krüger's estimate, obtained from a series of most careful investigations of Themis (one of the minor planets) gives $\frac{1}{1047 \cdot 16}$. The mean of the four last-named values $\left(\frac{1}{1047 \cdot 34}\right)$ may safely be accepted as a very close approximation to the true mass of the largest planet of the solar system. It is to be expected that the influence of Jupiter on Saturn, which seemed to Bouvard (before the discovery of Neptune) to indicate a mass of $\frac{1}{1070}$, will be satisfactorily accounted for by the value now assigned to Jupiter's mass.

The variable in Corona, whose appearance (sudden, we think, despite Mr. Hind's verdict) startled astronomers in May, and which had sunk to the 9th magnitude, increased in brightness to the 7th magnitude towards the end of August last; but Mr. Huggins's spectroscope revealed no traces of the bright lines which in May formed so marked a feature of the star's spectrum. The star has now returned to the 9th magnitude.

4. BOTANY AND VEGETABLE PHYSIOLOGY.

England.—*Homologies of the Flowers of Coniferæ.*—Mr. Andrew Murray has published an interesting paper on this subject, in which, at some length, he demonstrates that the male flowers are monopetalous and diandrous in the firs and pines, monopetalous and polyandrous in the cypresses and allied genera. The female flower is also monopetalous. In the young state, the petal is a small bract, sometimes green, sometimes even more richly coloured than the petal of the male flower, always petaloid in texture, at least at the margins. The author supposes the envelopes to have the following homologies:—1. Outermost envelope, or its appendage, corresponds to, in ordinary dicotyledons, the petal; in conifers, to the bract. 2. Next envelope corresponds ordinarily to the disk; in conifers, to the scale. 3. First covering of the fruit, ordinarily the pericarp; in conifers, the wing of the seed. 4.

Second covering of the fruit, ordinarily mesocarp; in conifers, cellular substance between 3 and 5. 5. Third covering of fruit, ordinarily endocarp; in conifers, the testa. The remaining envelopes of the nucleus of the ovuli in the conifers (*primine, secundine, &c.*) in no respect differ in appearance or function from those of other seeds, and therefore need not be specially noted.

Lichenology.—The Reverend W. A. Leighton continues his series of papers on this subject in the 'Annals.' He has lately given a notice of the Abbé Coeman's essay on the *Cladoniæ* of the Herbarium of the great lichenologist, Acharius, and the results of the application to his own herbarium of a chemical test as a means of deciphering species of Lichens. The reaction which is found so useful, is that of hydrate of potash, which in certain cases produces a yellow colour, whilst in others there is no reaction, or only a slight fuscescence. In no case, says Mr. Leighton, is the reaction of greater utility than in the difficult tribe of Cladoniæ, that crux of lichenologists, where its application enables us with admirable precision and exactness to determine the various species, to redistribute the confounded species, and to refer to their proper systematic places the innumerable varieties and forms which may resemble each other in external character.

Climbing Plants.—Herr Fritz Müller, who is so well known among zoologists by his many valuable contributions to their science, and more especially by his essay, entitled 'Für Darwin,' writes from Desterro, in South Brazil, to Mr. Darwin, on the subject of his paper on the movements and habits of climbing plants. Mr. Darwin, in that paper, says that he has seen no tendrils formed by the modification of branches, and even seems to entertain some doubt whether such tendrils exist. Herr Müller gives an account of various plants which are known to him exhibiting this structural phenomenon, and traces the following stages in the development of branch-climbers:—1. Plants supporting themselves only by their branches stretched out at right angles, for example, *Chiococca*. 2. Plants clasping a support with their branches unmodified, *Securidaca* (*Hippocratia*). 3. Plants climbing with the tendril-like ends of their branches. According to Endlicher, this is the case with *Helinus* (ramulorum apicis cirrhosis scandens"). 4. Plants with highly modified tendrils, which may, however, be transformed again into branches, for example, *Hecastaphyllum*, a Papillionaceous plant. 5. Plants with tendrils used exclusively for climbing, *Strychnos*, *Caulotretus*. The letter contains many other interesting observations, which may be read in full in the Linnæan Society's 'Journal' of November 29th. With respect to the thickness of the support which can be ascended by spirally twining plants, Herr Müller states that he has lately seen a trunk about five feet in circumference, which was thus ascended by a plant apparently belonging to the Menispermaceæ.

Newfoundland Heather.—Dr. Berthold Seeman has figured this form of *Caluna* in a late number of the 'Journal of Botany,' and proposes to give it a distinct specific name. When planted by the side of the common Scotch heather, it was observed that whereas the native plant stood the weather easily, this was browned and withered up by the cold. A full-blossomed variety of the heather is cultivated in German gardens, which is also observed to have this peculiarity of habit, and may perhaps be similar in other respects to the Newfoundland form. Dr. Seeman states that it is difficult to seize on any constant character of differentiation between the Transatlantic and Scotch forms, excepting this one of habit; at the same time he considers that they ought to be distinct species.

Pollen Grains as characteristic of Species.—Mr. Gulliver, F.R.S., communicates to the same contemporary his notes on the pollen grains of certain allied plants, which he finds differ most markedly in size and roughness. The pollen grains of *Ranunculus acris* are rough and very much larger than those of allied species, while *Lotus corniculatus* and *Lotus major*, which are sometimes declared to be identical species, present a most striking difference as regards size in their pollen-grains, those of *L. major* being invariably smaller than those of *L. corniculatus*.

The late numbers of the Journal also contain a paper by Mr. Carruthers "On the Structure and Affinities of Lepidodendron and Calamites," and many of the botanical papers which were read before the British Association at Nottingham.

The Cedars of Lebanon.—Dr. Hooker makes the following interesting communication to a recent number of the 'Gardeners' Chronicle':—"The Rev. M. Tristram, F.L.S., informs me of a most interesting discovery lately made in the Lebanon, *viz.* of several extensive groves of cedar-trees, by Mr. Jessup, an American missionary, a friend of his own, to whom he pointed out the probable localities in the interior. Of these there are five, three of great extent east of 'Ain Zabalteh,' in the Southern Lebanon. This grove lately contained 10,000 trees, and had been purchased by a barbarous Sheikh, from the more barbarous (?) Turkish government, for the purpose of trying to extract pitch from the wood. The experiment of course failed, and the Sheikh was ruined, but several thousand trees were destroyed in the attempt. One of the trees measured fifteen feet in diameter, and the forest is full of young trees, springing up with great vigour. He also found two small groves on the eastern slope of Lebanon, overlooking the Buka'a, above El Medeûk; and two other large groves containing many thousand trees, one above El Barûk and another near Ma'asiv, where the trees are very large and equal to any others: all are being destroyed for firewood. Still another grove has been discovered near Dûma, in the western slope of Lebanon, near the one discovered by Mr. Tristram himself. This gives ten distinct localities in the Lebanon, to the south of the originally discovered one, and including it. Ehrenberg had already discovered one the north of that locality, and thence northwards the chain is unexplored by voyager or naturalist."

The Flora of Ireland.—Mr. A. G. More and Dr. D. Moore have published their work entitled 'Contributions to a Cybele Hibernica,' which has been for some time expected. The work was one which was much wanted by Irish botanists, and appears to be creditably done. A grant from the British Association of 25*l.*, which was voted to Dr. E. P. Wright, of Dublin, for the purpose of investigating the flora of the north-west of Ireland, was handed over to the authors of this work, since they had already done much which Dr. Wright was contemplating, and by its assistance they have been enabled to finish their task successfully.

Acquisitions at the British Museum.—The national collection has lately been enriched by the invaluable series of Diatomaceæ which belonged to the late Dr. Greville, many hundreds of which were described by him for the first time, and figured in the 'Microscopical Journal' and other periodicals. They will now be accessible to all persons for purposes of comparison and identification, and, together with the collection of the late Professor Smith, also in the British Museum, form probably the largest and best collection of Diatomaceæ in the world. The Botanical department has also received an addition in the collection of ferns formed by the late Mr. Smith, which was considered to be, next to that of Sir William Hooker, the finest in existence.

FRANCE.—*Boussingault's Researches on the Action of Foliage.*—From the earlier part of these highly important investigations, it appears that leaves taken alone (avoiding the complication of roots, &c.) and exposed to the action of sunshine in pure carbonic acid gas, do not decompose this gas at all, or only with extreme slowness. Secondly, that in a mixture with atmospheric air, they decompose carbonic acid rapidly. The oxygen of the atmospheric air, however, appears to play no part. Thirdly, leaves decompose carbonic acid in sunshine as readily when this gas is mixed with nitrogen or with hydrogen. Finally, Boussingault determined that rarefaction of the carbonic acid by diminished pressure had the same effect as diluting it, and considered the case analogous to the oxidation of phosphorus by rarefied or dilute oxygen. In a continuation of his investigations, published in the 'Comptes Rendus,' Sept. 25, the author shows that carbonic oxide is not decomposable by foliage, and considers this as confirming his view, that leaves simultaneously decompose carbonic acid and water $CO_2 + H_2O = CO,H_2, O_2$, O_2 being liberated, CO,H_2 expresses the relation under which carbon is united with the elements of water in cellulose, starch, sugar, &c., *i.e.* in the important principles elaborated by the leaves, the composition of which is represented by carbon and water. In the third part of his investigations the author shows that detached leaves, kept in shade for many days, with the cut end of the petiole in water to prevent desiccation, preserve the power of decomposing carbonic acid whenever brought into sunshine. It is necessary that they be kept in oxygen, for in darkness oxygen is slowly transformed by the leaf into carbonic acid, through an operation answering to respiration in the animal. A healthy leaf, however, decomposes in sunshine far more carbonic acid than it forms in darkness. In eighteen experiments with oleander leaves, exposed to the sun from 8 A.M. to 5 P.M., in an atmosphere rich in carbonic acid, a square metre of foliage decomposed, on the average, over a litre of carbonic acid per hour, while in darkness only $\frac{7}{100}$ths of a litre of carbonic acid were produced per hour. In the complete absence of oxygen, leaves, as animals, die from the impossibility of respiration. Boussingault and his assistant, Lewy, were the first to analyse the air contained in a well-manured soil, which they found to be rich in carbonic acid. He has since examined the air contained in a branch of oleander in full vegetation, and found it to contain nitrogen, 88·01 per cent.; oxygen, 6·64 per cent.; carbonic acid, 5·35 per cent.; being about the same composition as the air of a well-manured soil. He now promises to demonstrate the direct formation of saccharine matter in leaves by the action of sunlight. These researches, obviously, have a most important bearing upon the distinctive functions of plants and animals, since it appears that oxygen is equally necessary to both.

5. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

Beyond the announcement of the discovery of a new metal by MM. Meinecke and Rossler,[*] there is no great novelty to record in our present Chronicle. These gentlemen mention that in the course of a mineral analysis they have found a metal, allied to those of the alkaline series, which gives a sharp dark-blue line in the spectroscope in a different position to that given by Indium. They promise a further account of the metal in a short time.

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[*] 'Zeitschrift für Chemie,' H. xix., p. 605.

With regard to Indium, Winckler[*] has published a process for its easy extraction from Blende. He treats the roasted blende with hydrochloric acid, then by an excess of zinc precipitates the indium together with copper, lead, cadmium, &c., and afterwards separates these metals by means of sulphuretted hydrogen and carbonate of baryta.

In connection with zinc we may mention the publication by B. Renault[†] of some notes on the phosphoretted compounds of this metal. He finds that zinc and phosphorus unite in many and variable proportions, and he describes no fewer than six phosphides, only one of which calls for notice. This is the compound $Zn_3 P$, which will keep without alteration even in the air, and serves well for the preparation of spontaneously inflammable phosphoretted hydrogen. The author prepares this compound by mixing one equivalent of phosphate of magnesia, with two of artificial sulphide of zinc, and seven of carbon. The mixture is heated in an earthen crucible, and the phosphide of zinc sublimes. Hydrochloric acid added to fragments of the phosphide, causes the evolution of gas which inflames at 30°, but with the powder, the spontaneously inflammable gas is obtained.

Mr. Carey Lea has suggested an extremely delicate test for the detection of iodine. To a solution, for example, suspected to contain iodide of potassium, the author adds, 1st, a drop or two of solution of starch, then a drop of a dilute solution of bichromate of potash, just sufficient to give a pale yellow colour to the liquid, and lastly, a few drops of dilute hydrochloric acid. The effect varies of course with the amount of iodine present, but with a solution of iodide of potassium, containing only $\frac{1}{100,000}$th, an abundant blue precipitate is obtained, which, however, becomes tawny as the dilution increases. In the case of great dilution, approaching to a half-millionth, merely a tawny shade is given to the solution.

The same indefatigable experimenter has carried still further his researches on the chemistry of the photographic picture. Contrary to the assertion of Vogel, he shows that light has an action on perfectly neutral iodide of silver, since he has produced an image on silvered glass, merely treated with solution of iodine. The physical part of the paper we may leave unnoticed here, and merely give the author's opinion that on an ordinary negative there are really four superimposed pictures: 1st, that produced by the physical action of light on iodide of silver; 2nd, another by the reduction of iodide to subiodide of silver, if the exposure has been sufficiently long; 3rd, one produced by light in connection with the organic matter of the film; and 4th, the reduction of bromide and chloride if present. With regard to the 3rd, it should be mentioned that the author has exposed an ordinary bromo-iodized plate, and then thrown it into a dilute solution of pernitrate of mercury, by which the iodide and bromide of silver are dissolved, and the film left clear as glass. Nevertheless, after the plate had been well washed, the image appeared when the developer was applied.

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[*] 'Journ. f. prakt. Chemie.' xciv., p. 414.

[†] 'Annales de Chimie et de Pharm.,' Oct., 1866.

Two correspondents of the 'Chemical News,' Mr. Spiller and Mr. Clarke, have recently called attention to the liability of the composition for making red fire to spontaneous ignition. The fact was well known with regard to red fire, but Mr. Clarke informs us that the composition for purple fire made with black oxide of copper, as it usually is, is almost certain to take fire of itself sooner or later; and he adds, that carbonate of copper should always be used in preference to the oxide.

On the border-land, between mineral and purely organic chemistry, we may notice the formation by R. Maly of an ether of tungstic acid by treating oxychloride of tungsten with strong alcohol. Tungstic ether forms a hard, brittle, glassy mass, insoluble in water, alcohol, and ether. When heated on platinum foil it burns with a smoky flame, and in the end yellow tungstic acid is left as the residue.

We have several times mentioned M. Berthelot's researches on the hydrocarbons, which have already thrown so much light on the constitution of these bodies, and which the author continues to pursue with unwearied industry. One of his latest published results is the synthesis of benzol. Our readers will remember that M. Berthelot has effected the direct synthesis of acetylene $C_4\,H_2$ by the union of carbon and hydrogen. He has now passed the acetylene so produced through a red-hot tube, by which he obtained a yellowish liquid, more than one half of which was benzol, the remainder being polymers, styrol, fluorescent carbides of hydrogen and retene, &c. The author therefore regards benzol as tri-acetylene:—

$$C_{12}\,H_6 = 3\,C_4\,H_2.$$

The reader who wishes to peruse this important paper at length will find it in the places indicated below.*

In another paper M. Berthelot describes the results of the action of heat on benzol and analogous hydrocarbons. Benzol when passed through a red-hot tube is decomposed with condensation into several hydrocarbons, the principal being phenyl $C_{24}\,H_{10}$. Chrysen $C_{36}\,H_{12}$ is another product, and there is a residue of other solid hydrocarbons. A mixture of benzol and ethylene passed through a red-hot tube yielded styrol $C_{16}\,H_8$ and naphthalin $C_{20}\,H_8$ as the principal products. Styrol heated to redness breaks up into benzol and acetylene, and reciprocally a mixture of benzol and acetylene when heated forms styrol. These and other interesting results will be found fully described in the 'Comptes Rendus' for November 5th and 12th, 1866.

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* 'Comptes Rendus,' xiii. p. 472. 'Chemical News,' No. 365, p. 254.

The occurrence of homologous compounds among the products of destructive distillation, has received another illustration at the hands of Dr. Anderson,* who has found propionic and butyric acids in the crude product of the distillation of wood.

Mr. Skey, a chemist at the Antipodes, sends word† that a substance resembling artificial tannin is produced by the action of nitric acid on bituminous coal or lignite. The substance is soluble in water, has a bitter taste, and is precipitated from its solution by gelatin and albumen.

Dr. R. Wagner has recently published‡ what would appear to be a very satisfactory process for the determination of gallo-tannic acid. It depends upon the insolubility of tannate of cinchonine. The author prepares a slightly acid solution of sulphate of cinchonine, 4·523 grammes in a litre. 1 cubic centimeter of this solution answers to 0·01 gramme of tannic acid. As indicator the solution is coloured with acetate of rosaniline. Rosaniline being also precipitated by gallo-tannic acid, a red colour is left, when the reaction has ended. In applying the test the author boils 10 grammes of the substance in pure water, dilutes to 500 c.cs. filters, and then takes 50 c.cs. to precipitate with the cinchonine solution. The precipitate collects together, and it is easily seen when all the tannic acid is thrown down. The calculations, and a number of determinations made by the process, will be seen in the paper quoted from, in which it is also mentioned that the precipitates may be put aside and the cinchonine recovered for subsequent use.

Frohde has lately shown§ that molybdic acid gives a sensitive and characteristic reaction with morphia. He dissolves molybdic acid in strong sulphuric acid, and a drop of this solution shows, with the smallest amount of morphia, or its salts, a beautiful violet coloration, which soon passes to blue, afterwards turns dirty-green, and, lastly, leaves a nearly colourless spot. A solution of molybdate of soda in sulphuric answers well for the test, which is said to be more sensitive than nitric acid.

Chloroform is subject to spontaneous alteration, which results in the disengagement of phosgene gas. Although the nose will generally serve to discover the presence of this gas, a delicate test is useful, and Stadeler points out that bilirubin, the red colouring-matter of bile, answers the purpose. When this body is brought in contact with the altered chloroform, it turns orange-red, and soon green.

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* 'Chemical News,' No. 365, p. 257.

† 'Chemical News,' No. 361, p. 206.

‡ 'Zeitschrift f. Analyt. Chem.,' 5, 1.

§ 'Archiv. der Pharm.' Bd. 186, p. 54.

Dragendorff gives* an easy process for obtaining bilirubin sufficiently pure. He simply extracts inspissated bile with sulphide of carbon, filters, evaporates, and then repeatedly extracts the residue with alcohol and ether. After this a red powder remains, which is sufficiently pure bilirubin. To prepare a small quantity quickly, fresh bile may be taken and diluted with water, and acidulated with a few drops of hydrochloric acid. After this it is shaken with a little bisulphide of carbon. The layer of bisulphide is then separated, evaporated, and the residue washed with alcohol and ether. The undissolved red powder can be used directly for the test.

Zalesky has isolated the poison of the Salamander. It is a creamy liquid, strongly alkaline, and having a bitter taste. It contains an active principle, precipitated by phospho-molybdic acid, and to which the author has given the name Salamandrine. Its composition is $\mathrm{C}_{34}\,\mathrm{H}_{60}\,\mathrm{N}_2\,\mathrm{O}_5$.

In conclusion, we may mention two papers of considerable practical interest. The first is the description of a process devised by Mr. Sutherland for the estimation of resin in soaps.† The author first decomposes the soap by boiling with strong hydrochloric acid; he then treats the cake of mixed fatty and resinous acids with strong nitric acid, by which the resinous matter is converted into soluble terebic acid, while the fatty acid is left comparatively unacted on. This process, though not rigidly exact, may afford reasonably approximate results.

The last paper is on the igniting point of Petroleum by Dr Attfield.‡ The igniting point of petroleum is a matter of dispute, partly in consequence of the different methods which chemists adopt in determining it, and, partly, because all are not agreed as to the exact meaning of the Petroleum Act. Dr. Attfield has devised a simple set of apparatus to ensure uniformity in the mode of operating, and thus removes one source of disagreement, if the apparatus be adopted. He uses simply a wide-test tube, in which the specific gravity may first be taken by means of a hydrometer. The tube is marked, so that in determining the igniting point, equal volumes of petroleum may always be taken—a point of considerable importance. A narrow thermometer answers for a stirring rod, while it indicates the temperature. Dr. Attfield recommends the use of a small gas-jet as a test flame, which he arranges so that it can be easily brought within the tube, and to within half-an-inch of the surface of the liquid. The petroleum is heated by passing the tube gently through the flame of a spirit lamp, or, better still, by placing it in hot water. When a thin blue flame is seen to run between the test-flame and the surface of the oil, the igniting point is arrived at.

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* 'Pharm. Zeitsch. f. Russland,' 3, 49.

† 'Chemical News,' No. 359, p. 185.

‡ 'Pharmaceutical Journal,' December, 1866.

PROCEEDINGS OF THE CHEMICAL SOCIETY.

At the first meeting of this season, held on the 1st of November, 1866, Dr. Hermann Sprengel exhibited and described an instrument for obtaining a vertical section of a heterogeneous mass of liquid preliminary to the determination of the average specific gravity. This instrument—which is specially applicable for taking samples of acid from sulphuric acid chambers, in which the heaviest acid is necessarily at the bottom of the chamber—is fully described, and its use explained in the 'Journal of the Chemical Society' for November, 1866.

At the same meeting, Mr. E. T. Chapman read a paper entitled "The Relation between the Products of Gradual Oxidation and the Molecular Constitution of the Bodies Oxidized." The paper gave an account of the results of an action of chromic acid on several organic compounds. Vinic alcohol submitted to the action of a mixture of bichromate of potash and sulphuric acid in sealed tubes yielded acetic acid without the production of any gaseous carbon compound. At one stage of the process, however, acetic ether was the only product. Amylic alcohol furnished valerianic acid. In the case of compound ethers, acetate of ethyl was converted entirely into acetic acid; acetate of amyl into acetic and valerianic acids. At high temperatures it was found that carbonic acid in variable quantity was produced.

One noteworthy result of the experiments was the observation that natural valerianic acid obtained from valerian root, behaves under the chromic acid treatment differently from the acid obtained by the oxidation of amylic alcohol. The real origin of the supposed natural oil is, however, doubtful. The author also obtained results which seem to show that fusel oil contains two isomeric alcohols, one of which is more easily oxidized than the other. The fusel oil which yielded these results is supposed to have been obtained by the distillation of a mixture of grain and rice.

At the meeting on November 15th, Dr. Daubeny read a paper "On Ozone." The author has made experiments at Torquay in the winter months, and Oxford in the summer months. In the former place the south-west and westerly winds were most strongly charged with ozone; and in the latter city, the easterly winds brought most. The results at Torquay Dr. Daubeny considers to prove the influence of the sea in increasing the amount of ozone. The principal natural source of ozone the author finds to be the air exhaled from growing plants, and he considers the generation of ozone in the process of vegetation to be one of the appointed means of nature for purifying the atmosphere from pernicious organic compounds. Dr. Daubeny, in his observations, used both Schonbein's paper, and the sulphate of manganese paper, but considers the first, if protected from light, to give the most reliable indications. It was admitted, however, by Dr. Daubeny himself, and most of the speakers who joined in the discussion, that more accurate tests for ozone are wanted. In reply to a question put by Dr. Frankland, the author remarked that the outbreak of epidemics was often ascribed to a deficiency of atmospheric ozone, but he had no evidence on the point.

In the course of the discussion which followed the reading of Dr. Daubeny's paper, Dr. Gilbert expressed some doubts of the identity of the ozone-like emanations from growing plants, and the odorous substance produced by the slow combustion of phosphorus in moist air. Dr. Odling mentioned also that he had found some of the properties of ozone wanting in the odour evolved on mixing permanganate of potash with an acid.

In closing the discussion, the President (Dr. W. A. Miller) observed that no one doubted the existence of ozone in the atmosphere; but it must be admitted that, as yet, the proof was very imperfect.

On the same evening, Mr. W. N. Hartley gave an account of a new body called "chlor-sulphoform," $C_2\ Cl_4\ S_3$.

The next communication was by Messrs. Chapman and Thorpe, who gave a continuation of the paper mentioned above. It detailed experiments on the oxidation of mannite and glycerine by chromic acid, by which it seems only formic acid is produced.

Mr. Chapman afterwards read a short paper "On the Synthesis of Butylene," which he has obtained by the action of zinc ethyl on mono-brom-ethylene.

DR. FRANKLAND'S LECTURE NOTES FOR CHEMICAL STUDENTS.*

'Lecture Notes for Chemical Students,' by a Professor who stands in the position of the first teacher of the Science in England, must necessarily command a large share of attention; and these notes will receive it no less on account of the position of the author than the essentially novel character of the book.

We may, at the outset, express our regret that Dr. Frankland has not published a full educational treatise on the Science. This book he correctly describes as a skeleton, which the student is himself to clothe with already known facts. For these he is referred to various works, in no one of which will he find the same system of nomenclature and notation, and no two of which we believe, he will find completely agreeing one with the other. To the "Student" this can be no other than a source of embarrassment, and will, we fear, tend to limit the use of these "notes" to the students attending the author's own classes.

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* 'Lecture Notes for Chemical Students, Embracing Mineral and Organic Chemistry.' London: Van Voorst. 1866.

More advanced chemists, however, will go through the book with great interest. They will find a very successful attempt at a complete and consistent system of nomenclature and notation; and for that reason alone every chemist will wish for the book a wide circulation. With regard to nomenclature, the author makes the following remark, with which all chemists will agree:—"The chemical name of a substance should not only identify and individualize that substance, but it should also express the composition and constitution of the body, if a compound, to which it is applied. The first of these is readily attained, but the second is much more difficult to secure, inasmuch as our ideas of the constitution of chemical compounds—the mode in which they are built up as it were—require frequent modification." On this account the author adds, "all attempts to frame a perfectly consistent system of chemical nomenclature have hitherto been only partially successful."

It would be superfluous to allude here more particularly to the system Dr. Frankland has adopted; but it is only fair to remark that Professor Williamson had already led the way to it.

The system of notation made use of is, to a great extent, original, and not a little interest is given to the book by the introduction of "graphic formulæ" in illustration of the atomic constitution of bodies. Some of these formulæ, particularly those of minerals, for which the author owns himself indebted to Mr. McCleod, display remarkable ingenuity in their construction.

It is beyond our purpose here to attempt anything like a review of the work. The very first sentence, the definition of Chemistry, challenges some discussion; but we pass by it to notice one most valuable feature of the book for students. A "large amount of space is devoted to equations expressing the reactions occurring in the formation and decomposition of the substances treated of." Anyone who has been, or is, a student of Chemistry, will recognize the value of this part of the work, which we may recommend to both students and teachers, in the hope—vain though it may be—that it may bring us one step nearer the adoption of one uniform system in teaching what we may be excused for considering the most important of all sciences.

6. ENGINEERING—CIVIL AND MECHANICAL.

The subject which has generally attracted the most interest during the past quarter has been the trial of H.M.S. 'Waterwitch,' which has been fitted with a Ruthven's hydraulic propeller. The results as to speed proved, however, anything but satisfactory. With an indicated engine power of 750 horses, scarcely more than one-third of that power was ascertained to have acted effectively in propelling the vessel, and the speed attained was but nine knots an hour. The mode of propulsion is by the ejection of jets from the sides of the vessel, a short distance above water line, the reaction of which upon the water causes the ship to be propelled forward in a direction opposite to that in which the jets act.

The great question of guns *versus* armour-plates, is still undecided; for whilst, on the one hand, guns can now be made that will pierce any thickness of metal hitherto employed as armour for ships, it is still possible to increase that thickness to 15 or even 20 inches, if necessary, which would defy the largest guns yet manufactured. Two iron-clads are at present under construction for the British Navy, namely, the 'Hercules' and the 'Monarch,' and their armour-plates will vary from four to nine inches in thickness.

Recent experiments at Shoeburyness have sealed the fate of steel shot and shells, and resulted in the final approval of Major Palliser's projectiles for battering purposes; and chilled-iron projectiles will henceforth be exclusively employed by sea and land for penetrating iron-plated defences.

The Armstrong Gun would appear to have had its day, for land purposes at least, and the Royal Gun Factories at Woolwich are now principally employed in the manufacture of large numbers of the Fraser guns. The Ordnance Select Committee has recently recommended that we should revert to muzzle-loading guns for field use, and that the existing store of breech-loading Armstrongs should be converted, if possible, into muzzle-loaders on the Woolwich principle. With regard to small arms, the Sneider principle of converting our Enfields into breech-loaders, does not, apparently, quite satisfy our military authorities. The Secretary of State for War has invited proposals for breech-loaders to replace the present service rifles, offering four prizes for the best guns and cartridges, and a sum of 300*l.* is to be allowed to each accepted competitor for expenses.

Constant improvements are now taking place in the construction of locomotives. Attempts are being made to roll locomotive boilers in one single tube, which would have neither seam nor joint, and several patents have recently been taken out with that object. Should the attempt prove successful, we may count upon a considerable direct gain in the strength of boilers, and, probably, upon the disappearance of "furrowing," which generally appears to be localized in the near neighbourhood of a seam of rivets. A few years ago the safe limit of steam pressure in a locomotive boiler was considered to be but 50 lbs., and now many engines on the lines about London are worked at 160 lbs. Great advantage would follow the use of a higher pressure, as it would enable the steam to be worked more expansively, and this may probably soon be accomplished, since a small steel boiler has recently been made for Mr. Salt, of Saltaire, which has not one rivet in it; all the joints are welded, and it has been proved to 300 lbs., and is intended to work at 250 lbs. There is a growing tendency greatly to increase the weight of locomotives, as there is a constant demand for engines of greater and greater tractive power, and Mr. Fairlie is building one of 72 tons weight for the Paris Exhibition. By his plan of double bogies of coupled wheels, each driven by a separate pair of cylinders, he not only distributes the weight of the engine upon eight or twelve points, as required, but he obtains great ease of working round very short curves, the governing wheel base being that only of each bogie. On the Northern Railway of France four-cylinder engines have been in use since 1863, and it has been proved, by experience, that the cost of maintenance of a four-cylinder locomotive is less than that of ordinary engines in proportion to the power developed.

Two very useful little machines have lately been designed by Mr. R. Angus, Locomotive Superintendent, North Staffordshire Railway, the one being for the purpose of planing the valve-faces, and the other for boring the cylinders, of locomotives whilst they remain fixed on the engine, thus saving a large amount of manual labour and time.

Delegates have, during the past quarter, arrived in London from Nova Scotia, New Brunswick, and Canada, for the purpose of arranging for the commencement of the Intercolonial Railway to complete the line of communication between Halifax and Quebec. By the shortest of the three routes that have been surveyed, the distance is 588 miles, of which 192 miles are already occupied by railways, leaving 396 miles to be constructed to complete the communication. The estimated cost of construction is 8,300*l.* per mile, or 3,286,800*l.* for the whole length, and it is understood that an Imperial guarantee of the interest upon 3,000,000*l.* has been conceded for the line.

A short line of railway has recently been opened in one of the most hilly outskirts of Paris, namely from Enghien to Montmorency. The length of this new line is less than two miles, and its peculiarity is that it consists almost entirely of curves of 300 metres radius, and inclines of 0·045, with the exception of a level bit of 150 metres at either end. The completion of the Chemin de Fer de Ceinture, the circular line to connect all the Paris termini, and its continuation to the Champ de Mars, for the purposes of the Exhibition next year, is now in hand, and presents many features of interest. A curious and ingenious method of enlarging the post-office carriages has been adopted by the Lyons Railway Company. Two vans are connected together by a strong junction of leather, arranged bellows-fashion, so that it expands and contracts with the movements of the buffers, and forms a safe means of communication between the two carriages.

A remarkable work is now in progress at the Place de l'Europe, in Paris. From that point, which is some 170 feet square, six roads, each 50 feet wide, diverge symmetrically, under which complication of thoroughfares the Chemin de Fer de l'Ouest passes through three openings, two of which are square, with spans of 98 feet 6 inches, and 82 feet respectively, and the remaining one skew, with a clear opening of 98 feet 6 inches, and a span of 102 feet.

In September last the opening took place of the section of the Madrid, Saragossa, and Alicante Railway, between Venta di Cardenas and Andujar, across the Sierra Morena, which was the only piece of line unfinished on the great route from Irun to Cadiz.

The Railways in Algeria conceded to the Lyons and the Mediterranean Railway Company are now actively in progress. The principal works being constructed at the present time are the prolongation of the Algiers and Blidah Railway to the valley of the Chetif, the Oran and Relizane Railway by Saint Denis-du-Sig, and the line from Phillippeville to Constantine.

From the last annual report on the Mont Cenis Tunnel, it appears that up to the end of last June the progress made at the Modane, or French side, amounted to 2,321 metres, of which 2,031 metres were completely finished. At Bardoneche, on the Italian side, the tunnelling was found to extend to 3,470 metres, of which 2,533 were finished. On the French side, the quartz rock had been met with at the exact spot anticipated by the geologists and engineers, and was not expected to extend beyond the 400 metres originally suggested. On the other hand, the work at the Italian end is reported to have made more rapid progress, in consequence of the softer character of the material to be passed through. The total length to be excavated is 12,220 metres, or about 7½ miles.

In London, the works of the Metropolitan District Railway continue to make satisfactory progress, although they have been greatly impeded, owing to the numerous difficulties which beset the construction of an underground line through the metropolis. In laying out such a line, not only have the levels of various streets passed under to be considered, but also those of the sewers, these latter often giving considerable trouble. At all points numbers of gas and water mains had to be dealt with, whilst at numerous parts of the works special modes of construction must be adopted. The Metropolitan Extension Railway to Brompton and Notting Hill, passes in its course immediately beneath several fine and lofty houses at Pembridge Square. In order to avoid pulling these houses down, they have in the first place been underpinned; trenches were then dug, in which the side walls of the railway tunnel have been built, and wrought-iron girders are now being placed from wall to wall; the spaces between each girder will be arched over with brick in cement, and upon these the foundations of the houses will ultimately rest. The other principal works in progress in London are the Holborn Valley Improvement, the Thames Embankment, and the Metropolitan Main Drainage. With reference to the latter work, the quantity of sewage to be disposed of on the north and south sides of the Thames amounts to 10,000,000 and 4,000,000 cubic feet respectively, and the sewers have been proportioned for an increase up to 11,500,000 c. f., in addition to a rainfall of 28,500,000 c. f. per day on the north side, and up to 5,720,000 c. f., and a rainfall of 17,250,000 c. f. per day on the south side. Altogether there are now in London about 1,300 miles of sewers, and 82 miles of main intercepting sewers, and the pumping power amounts to 2,380-horse power nominal, whilst the execution of the main drainage works has involved the excavation of 3,500,000 cubic yards of earth, and the consumption of 880,000 cubic yards of concrete, and 318,000,000 of bricks.

An improved machine for tunnelling through soft ground has been invented by Mr. R. Morton, of London. It consists of a tube the size of the tunnel, formed of rings of cast iron, in front of which a large wrought-iron wedge-shaped shield is pushed by hydraulic pressure. This shield is made at the back of a similar section to the tube, over which it makes a movable but watertight joint; the pointed shield having been thrust forward a few feet, another ring of segments is added to the tube inside the shield, and the work goes on as before.

On the 11th October the inauguration of a graving dock at Suez took place. The dimensions of the dock are sufficient for it to contain ships of the largest tonnage, its length being 492 feet, its breadth 95 feet, and depth, 32·8 feet. The total cost of the work amounted to 360,000*l.*

Mr. Richardson's experiments in Woolwich Dockyard on the use of petroleum as fuel are likely to lead to very important results. Already we hear that one of the locomotives on the Scinde Railway is about to be fitted with apparatus on this gentleman's plan, and in the event of the experiment proving successful, it is intended to take advantage of the large quantities of petroleum which are procurable from Assam.

One of the four great tubes of the Waterloo and Whitehall

Railway is now completed at Messrs. Samuda's yard, Poplar. It is 230 feet long, 12 feet 9 inches internal diameter, and is formed of ¾-inch boiler plate, surrounded by four rings of brickwork; its weight as it lies is nearly 1,000 tons, Bulkheads are to be fitted at each end, when it will be floated to its destination above Hungerford Bridge. Here an inner ring of brickwork will be built inside it, and it will then be sunk upon its piers, and its ends secured in a junction chamber.

A pneumatic despatch tube is now being laid down in Paris, from the telegraph office near the Grand Hôtel, to that in the Place de la Bourse, and others will shortly connect those with the central telegraphic office on the other side of the river, the head-quarters of the post-office, and other stations. The system adopted in Paris is the reverse of ours. While we exhaust the air in advance, our neighbours' system is to compress it behind the despatch truck, at a pressure of one atmosphere and a half.

The surveys for the Russo-American telegraph have been completed from Anadyrsk to the Amoor, a distance of 6,000 versts, and the direction of the line has been determined. As soon as the sea of Ohkhotsk shall be free, vessels belonging to the Telegraph Company are expected to arrive at Guigiga from America with the necessary materials for commencing the works immediately. Already between Anadyrsk and Ohkhotsk the works have been commenced with the assistance of the inhabitants of the country, who are engaged in constructing houses and trimming trees to serve as telegraph posts.

An iron floating dock for Bermuda is now being constructed by Messrs. Campbell, Johnstone, & Co., of North Woolwich. It is to be capable of docking ships of the Bellerophon class when waterlogged; it is fitted with a caisson at each end, and has a double bottom and sides 20 feet apart. Its internal dimensions are—length, 330 feet; breadth, 84 feet; and depth, 52 feet.

The Norfolk Estuary Company have recently completed another embankment of a mile and a half in length, at Walferty, reclaiming another 300 acres of land in the "Wash." This now makes a total of about 500 out of the 32,000 acres to be recovered from the sea.

The new Ladoga Canal has recently been opened for traffic. The first canal was commenced by Peter the Great, in order to develop the commerce of St Petersburg; it, however, proved inadequate to its purpose, owing to the defective system of locks. The new canal has no locks, and thus the project of Peter the Great, who intended that the first canal should be constructed without locks, is now realized.

The new screw pile pier at Brighton was opened on the 6th October last. The entire length of the structure is 1,115 feet; it is approached from the shore by an abutment 290 feet long and

140 feet wide; a fine promenade, 560 feet long by 50 feet wide, leads to the pier head., which is 310 feet long by 140 feet wide. The pier head has an area of 39,000 feet, and at each end of its four corners is an ornamental tower, two similar edifices adorning the abutments also.

The Cincinnati Suspension Bridge is rapidly approaching completion. Its total length, including the approaches, will be 2,252 feet; length of main span from centre to centre of the towers, 1,057 feet; length of end spans, 281 feet; width of bridge in the clear, 36 feet; and height above low water, 100 feet. It is supported by two cables of 12½ inches diameter, made up of 7 strands, each of which contains 740 wires. The floor beams are of wrought iron; two iron trusses, 10 feet high, will separate the footways from the carriageways, and an ornamental iron railing will protect the foot passengers on either side. Wrought-iron girders, 30 feet long and 12 inches wide, will run the entire length under the middle of the bridge.

7. ENTOMOLOGY.

(*Including the Proceedings of the Entomological Society.*)

In 1863 the Linnean Society published the first part of a memoir by Sir John Lubbock, "On the Development of *Chloëon dimidiatum.*" The second and concluding part of that memoir has just appeared in the twenty-fifth volume of the Society's 'Transactions,' p. 477. It is generally believed that all insects, with few exceptions, pass through three definite stages of existence after leaving the egg; but in the case of *Chloëon* there are no such stages; instead we have a series of gradations. It is true that the Ephemeridæ, the family to which *Chloëon* belongs, have been long known to have their metamorphoses incomplete, but we are indebted to Sir J. Lubbock for a definite account of their various changes. The condition in which the young *Chloëon* leaves the egg is uncertain, but the smallest specimens being only 18-800ths of an inch in length, and quite colourless and transparent, it is assumed that these are in their "first state." From this point there are not less than twenty states (or moultings), through which the insect progresses before it leaves the water, in which it has hitherto passed its life, to assume the "proimago" form, and this differs apparently from the perfect insect chiefly in certain peculiarities of the wings and legs. It is quite impossible here to follow the various changes which are minutely detailed in the two memoirs; we can only observe that it is not until the eighteenth stage that the external sexual characters of the males begin to show themselves, and that in some of the stages a sort of retrograde movement takes place.

It is one of the conclusions of the author that "external forces" acting on the larva produce those changes in the organization which have reference to its immediate wants rather than to its final form, and this, he thinks, accounts for "those cases in which animals, very similar in their mature condition, are very unlike in their earlier stages." In reference to "dimorphism" or "polymorphism," Sir J. Lubbock would confine the term to the cases of those animals or plants which "preserve themselves at maturity under two different forms," as in Ants and Bees: the "differentiating action of external circumstances, not on the mature but on the young individual," resulting in another series of phenomena, many of which have been described under the name of alternation of generations, he would distinguish by the term "dieidism" or "polyeidism."

A discussion on the nature of Pebrine (the silk-worm disease) has been recently carried on in the 'Comptes Rendus' between MM. Becamp, Joly, and Pasteur. The last-named author believes the "vibratory corpuscules" (one of the peculiarities of the disease) to be pathological productions analogous to the globules of pus, or of the blood. M. Becamp, on the contrary, considered them to be of a vegetable nature.. M. Joly had also observed in 1862 innumerable quantities of infusoria, which he described under the name of *Vibrio aglaiæ* mixed with the vibratory corpuscules; these corpuscules have since been stated to owe their origin to the *Vibrio*, but M. Joly denies this and asserts the *Vibrio* to be the effect and not the cause of the corpuscules. Of the origin of the disease nothing seems to be known, but, as a remedy, M. Becamp suggests the vapour of creosote, which, although it would not directly destroy the disease, would prevent the formation of spores by which the disease is propagated.

The Zoological Society has recently published a paper by Mr. Pascoe, on the "Coleoptera of Penang;" the writer attempts to show that "the area into which the earth's surface may be divided in relation to its organic productions, will not hold good for all classes, or even in some cases for all orders;' 'and that "so far as the Coleoptera are concerned, the Malayan region, with its centre in Borneo, finds its South-eastern limit in New Guinea, Australia constituting a very distinct and remarkable region of its own."

Messrs. Lovell Reeve and Co. have issued another of their cheap works on Natural History; it is entitled, 'British Bees: an Introduction, &c.,' by W. E. Shuckard. It is remarkable for its "spirit of captiousness," and might have been written twenty years ago so far as most of its statements are concerned; indeed the author tells us that "from the length of time that has intervened," the "facts recorded have become so blended in his mind," that whether they are the result of his own observations, or of "diligent study" (of the observations of others ?) he "can no longer separate their sources."

Mr. Roland Trimen, of Cape Town, has published the second part of his Rhopalocera Africæ australis (South African Butterflies), including the Satyridæ, Eurytelidæ, Lycænidæ, and Hesperidæ.

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY.

Sept. 3.—Among the exhibitions was a small collection of Coleoptera from Jamaica made by Mr. Gloyne. In reference to the Ailanthus silk-worm, Prof. Westwood said that he had found wasps very destructive to the young caterpillars. Mr. Trimen communicated a paper on the Butterflies of the Mauritius. This portion of the fauna of that island appears to be of decidedly African origin, most of the species being identical with those found in South Africa and Madagascar. There were only twenty-five species. Mr. F, Smith read an account of a collection of Hymenoptera—mostly Bees—sent to him from Catagallo, in Brazil. It contained the female of *Trigona*, the male only of that genus having been previously known; in the gravid state their abdomens were enormously distended, and in this respect they bore a remarkable similarity to the same sex of the white Ants (*Termes*).

In consequence of the new arrangement with reference to the Meetings of this Society at Burlington House, no meeting was held in October.

Nov. 5.—Mr. Janson exhibited some rare Coleoptera from Tasmania. Mr. Stainton exhibited a collection of Tineina from Asia Minor and Syria. Some large galls from the elm, supposed to be formed by Aphides, were shown by Mr. F. Smith.. A singular case or covering of a species of *Coccus*, resembling a small limpet-shell (*Patella*), from Port Lincoln, was sent for exhibition by Mr. Angas. The President (Sir J. Lubbock) brought under the notice of the meeting specimens and drawings of a new Myriapod found in his grounds at High Elms; it was remarkable for its small size, and for having only nine pairs of legs; it was proposed to be called *Pauropus*.

The Rev. Douglas Timins communicated a note "On the Habits of *Argynnis Lathonia*, in the north of France." Mr. M'Lachlan read a paper "On new Genera and Species of *Psocidæ*." Mr. E. Saunders read a paper, entitled "Descriptions of Six New Species of *Buprestidæ*, belonging to the *Chalcophorides* of Lacordaire."

Nov. 19.—Mr. Stainton exhibited drawings and specimens of the *Stathmopoda Guerinii*, bred from *Aphides* galls found on the *Pistacia terebinthus*, and sent by Dr. Staudinger from Celles-les-

Bains, in the Ardèche. This is one of the very few cases in which a moth is found as an inquiline of a gall; another such case Mr. Stainton stated comes to us from North America. Dr. Sharp exhibited *seventy-one* species of Coleoptera new to Britain, eleven of these, it was believed, were unknown on the Continent; descriptions of the new species were read. Mr. Meek exhibited an undescribed *Noctua*, taken at Bermondsey, and *Dicrorhampha fulvo-dorsalis*, taken in North Devon, and new to the British list. Prof. Westwood, in introducing the subject of an extraordinary hermaphrodite butterfly (*Pieris Pyrrha*), a drawing of which was exhibited, took occasion to make several observations on the Darwinian hypothesis. Mimetic forms, he considered, could only be looked upon as illustrations of the law of resemblance; he believed that all species were created with the same characters and attributes that they now possess, and consequently that there was no "relationship" between species even of the same genus, but that "similarity" alone constituted the bond of union. He was replied to by Messrs. Wallace and Bates, and a discussion ensued in which Dr. Sharp, and Messrs. M'Lachlan and Pascoe took part.

8. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

THE flow of geographical knowledge is something like that of that great river, which has at all times attracted and even is now attracting the principal attention of travellers—it is of an intermittent character. Occasionally an overwhelming flood pours down upon us, so that we are unable at the time to make full use of its fertilizing powers, and we have to wait until the waters have somewhat subsided before the seeds of rational theory can be sown upon the new alluvium. The present is rather the time of ebb. But few travellers have of late returned to these shores, and though much solid advance is being made by means of accurate descriptions and statistics, but little startling enterprise attracts the attention of those who are dazzled by hair-breadth escapes.

In Abyssinia English captives still linger, though additional tidings and gradual steps towards their ultimate return are from time to time reported. The Europeans supposed to be held in captivity in Somali land, where they were cast by the shipwreck of the St. Abbs, are now being sought by a native, whose diligence has been stimulated by the promise of 100*l*. per head for all brought back in safety.

The report now published, with maps, photographs, &c., of the

Palestine Exploration Fund is of the character which we have described above, a solid increase to our knowledge of an already tolerably well-known country, but it contains no startling adventure to make it attractive to any but the scientific mind. The sites of forty-nine places of importance have been determined with accuracy, amongst these the exact position of the synagogue at Capernaum. The scenes of many events in the Old and New Testaments have been fixed, the main back-bone of the country been mapped out, besides photographs of natural objects, ruins, inscriptions, &c., prepared. Much light is likely to be thrown upon a subject as yet but little understood, *viz.* Semitic Palæography, of which several scholars are springing up. M. Terrell has sent a paper to the French Academy on the composition of the Dead Sea, in which he states that he distinctly saw small fish thriving well near the site of the ancient Sodom.

The regions of Cambodia and Siam have been visited by Mr. J. Thomson, who has photographed many most interesting ruins of ancient cities and temples. An account of these was read before the British Association, and it is probable that a fuller narrative will appear before long of a very carefully undertaken and successful journey in search of almost unknown records of a forgotten civilization.

In Australia it was reported that the remains of Dr. Leichhardt had been discovered by the exploring party fitted out for that purpose, but the news turns out to be unfounded. On the other hand, it appears that the leader of the expedition, Mr. Duncan McIntire, had died from fever, but the search was being continued under Mr. Campbell. The continent has again been crossed from Victoria to the Gulf of Carpentaria, but the main objects of the expedition are reported to have failed. We are now promised speedier intelligence by a new route to Australia—the natural one, *viâ* Panama. The journey outwards was very successfully performed, and New Zealand in particular reaps the benefit of the change; but the homeward mail, though starting a few days before the so-called overland mail, arrived in this country after its rival. A careful study of the ocean currents and the periodical winds may perhaps help to overcome some of the difficulties.

One of these currents, the Gulf stream, is said by M. Grad to keep its identity beyond Spitzbergen and Nova Zembla into the Polar Basin, thus affording open sea far to the north of these islands, where an entrance must be sought by future travellers searching for the North Pole—a subject we have discussed in a former number. Slight alterations in the direction of this current, arising from the abrasion of rocks where it first enters the ocean, are from time to time reported, leading, we may suppose, to extensive changes in the effects on this side of the Atlantic. Similar changes are taking place in the Niagara Falls. The Horseshoe Fall has become more triangular, and it is said more beautiful. It has retired considerably on the American side.

The American rivers are undergoing a considerable change. It is not to be wondered at that Mr. Marsh, an inhabitant of that continent, should have been struck with the power that man has in altering the appearance of the country, and consequently its atmospheric phenomena. The book* he wrote some time back could receive no more striking illustrations than from his native continent. The clearing the primeval forests, the cultivation of the land, and the diversion of drainage in new directions have led to astonishing results. The mighty Mississippi is developing sand-banks and shoals, and is running with steadily decreased stream. The rapid rising after rain no longer takes place, and the navigation of the river is much altered in character.

The first separate map of Candia, a place about which we are all now beginning to inquire, has lately been published by Mr. Wylde. It is extremely clear and distinct, and will be useful for reference, both during the revolution, and also when that revolution has accomplished its object.

It is not often that we have to record honour done to scientific men. It is with great pleasure that we chronicle the fact that Mr. Baker has received knighthood at the hands of Her Majesty, and that Captain Speke has been made Commander of the Bath, both to commemorate their researches about the head waters of the Nile. Whilst mentioning the notice taken of the enterprise of these gentlemen, we cannot pass over the intrepidity, the self-denial, and the patient endurance of the wife of the former. It is pleasant to think that whilst she endured privation, assisting and being assisted by her husband, she with him receives a portion of the honour bestowed on him.

PROCEEDINGS OF THE ROYAL GEOGRAPHICAL SOCIETY.

At the commencement of the session of 1866–7 the President, Sir Roderick I. Murchison, gave a slight sketch of recent geographical doings, and mentioned some of the papers that it was expected would be read at the forthcoming meetings. But little that is new or startling had been effected, but work was going steadily onward. Dr. Livingstone is advancing and gaining important knowledge as to the watershed of Africa. A letter, of which an abstract is given below, was read at a subsequent meeting detailing his discoveries. Mr. W. Chandless, the recipient of the Victoria Medal for his exploration of the Purus river, has examined its tributary, the Aquiry, and is expected before the end of the session to read in person a paper on his discoveries. The rivers of Caravaya, in Southern Peru, had been explored for three years by Don Antonio Raimondy, who will furnish another paper on this subject. The expedition to the North Pole had not received much attention from the late government, it was to be hoped that the present would feel more fully the necessity of satisfying the expectations of the scientific men, not only of this country, but of all Europe. With an allusion to the Leichhardt expedition and the monument to Sir John Franklin, erected near the Athenæum Club-house, which has since been uncovered, the address concluded, and was followed by a paper on Mr. W. H. Johnson's recent journey from Leh, in Ladakh, to Khotan in Chinese Tartary. It appears that Mr. Johnson was born and educated in India, and that he was engaged on the Great Trigonometrical Survey of India. Whilst in this pursuit he was residing in the extreme northern limits of the territories of the Maharajah of Cashmere, and on this occasion was invited by the Khan of Khotan to visit this territory. The principal novelty that he saw was the city of Ilchi or Khokan, which had previously been visited only by Marco Polo, Benedict Grey, and a few Jesuit missionaries. The whole of this country has, until quite lately, been under the dominion of the Chinese, but since they have been so weakened by internal revolution and war with England, these districts have revolted and asserted their independence. All communication with China being at an end, they are anxious to open a system of commerce with India, but the high tolls levied by the Maharajah of Cashmere have almost entirely prevented this desirable consummation. A more direct route was afterwards taken by Mr. Johnson over passes from 15,000 feet to 18,000 feet above the sea-level, which, it is hoped, will be found available for the produce of the country, metals, jade, coal, cereals, cotton, and especially fine wool, of which latter there appears to be enormous quantities, from this the largest pastoral region in the world. This district had in former times been the stronghold of the Buddhist religion in Central Asia, now the inhabitants are essentially Turkish, and speak Turkish exclusively over an enormous district. It is anticipated that the commerce of this country will be of great importance, the more so as Russian influence was not likely to be strongly exerted in this direction.

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* 'Man and Nature; or, Physical Geography as modified by Human Action.' By G. P. Marsh.

The letter from Dr. Livingstone, to which we referred above, gives an account of his having discovered an excellent harbour about 25 miles to the north of the Rovuma river. The entrance is some 300 yards wide, and if this be considered the handle, the rest of the harbour may be looked upon as the blade of a spade on cards. After leaving this harbour he returned to the Rovuma and advanced up its north or left bank as far as Ugoniano, the confluence of this Rovuma or Louma, and the Louendi, a larger stream coming from the S.W. Dr. Livingstone expresses his determination to make this spot, where he has been well received and is in the confidence of the chief of the Makonde, his head-quarters, until he has fully explored the Lake Nyassa and determined its relationship to the other great lakes and the water system generally. The Makonde have some notion of a Divine being, nevertheless the Arabs had done nothing towards proselytism, a circumstance which is reported of them elsewhere.

An interesting paper, "On the Physical Geography of Natal," was read by Dr. R. J. Mann, who exhibited various maps and diagrams illustrative of the experience gained in an eight years' residence in the country. The colony forms a portion of the peculiar raised coast which surrounds the flatter interior of Africa. In consequence the rapid slope from the coast to the Drakenberg mountains, meets the sea breezes in the summer, causing a rainfall of 24 inches, whilst the winter monsoon brings but 6 inches of moisture, affording a remarkable climate, well suited for most tropical and temperate vegetation, but unsuited to other plants, amongst which is especially to be remarked the vine. The harbour of Natal admits vessels of 700 tons, and could easily be made available for those of larger tonnage.

9. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

Until recently all deposits containing gold *in situ* were generally considered, on the authority of Sir R. I. Murchison, to be of Palæozoic age,[*] notably Lower Silurian. Sir Roderick Murchison also believed that, in all cases, the gold was introduced into these ancient rocks during the Tertiary period. But we now possess a more perfect knowledge of the phenomena attending the occurrence of gold, and are proportionately better qualified to discuss the question, and one consequence has been that these old theories have been entirely contradicted by well-ascertained facts. In the first place, fossils were discovered *in situ* in the auriferous slates of California in the year 1863, which, on examination, proved to be of Jurassic age;[†] then, Professor Whitney has remarked that not a trace of any Silurian or Devonian fossil has ever been found in California; but, on the other hand, gold occurs in many localities in rocks as new as the Cretaceous.

We may conclude, therefore, that the Geological Survey of California has effectually disproved the old views; but they had been previously shown to be erroneous by Mr. David Forbes, who in 1860* reported the presence of gold in Upper Oolitic strata in South America due to the eruption of dioritic rocks of still younger age. More recently Mr. Forbes has published† a more general conclusion, to the effect that there have been two epochs of auriferous impregnation, namely, (1) the older, or granite intrusion, which is not older than the Upper Silurian, nor younger than the Carboniferous strata; and (2) the newer, or dioritic outburst, which Mr. Forbes calls Post-oolitic, and which is probably as recent as early Cretaceous.

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[*] 'Quarterly Journal of the Geological Society,' vol. viii. p 134.

[†] Whitney. Report on the Geology of California.

Mr. Selwyn's last report to the Government of Victoria "on the probable age of the Lower Gold-drifts"‡ makes public a view which is antagonistic to that enunciated by Mr. David Forbes. He believes that the quartz-veins of Victoria belong to two groups: an older, which is non-auriferous, and a younger, which is auriferous. From the former he believes the Miocene gravels have been derived, they being entirely barren; and by the degradation of the latter he considers that the rich Pliocene gold-drifts have been produced. If this interpretation be correct, we have proof of a third period of gold-impregnation, namely, in later Tertiary times.

The last number of the Transactions of the Geological Society of Glasgow (vol. ii., part 2) is a most creditable production, and contains, amongst many papers of merit, one "On the Auriferous Rocks and Drifts of Victoria," by Mr. W. Cameron, well worth a perusal by those interested in the subject. But the paper to which we must especially draw attention, is that by the Rev. H. W. Crosskey "On the relation between the Glacial Deposits of Scotland and those of Canada." The author infers, from a study of Dr. Dawson's papers on the Canadian deposits, that "the difference between the glacial fossil fauna of Canada and that now existing in the Gulf of St. Lawrence is far less marked than the difference between the glacial fauna of the Clyde-beds and that now existing in the Firth;" but even in Canada the difference gives a more arctic character to the fossils; and in Scotland, as is well known, this arctic element is the predominant characteristic. In Canada also, the beds occur in a distinct order, whereas in the Clyde-district their order is only a matter of inference. Another point is that the fossiliferous beds are superimposed, in both countries, on the true Boulder-clay, beneath which occurs in Canada a peaty deposit corresponding in position with the vegetable remains found at Chapel-hall, near Airdrie. Speaking generally, about two-thirds of the Scottish species occur fossil in Canada, leading to the inference that the climate at the period of their entombment was slightly colder than that of the Gulf of St. Lawrence at the present day; but the author thinks that they cannot be considered to mark "the extreme point of cold reached during the epoch; but rather as indicating the commencement of slightly milder climatic conditions than had hitherto prevailed." Mr. Crosskey also suggests that the conditions which produced the colder climate of Scotland during the glacial period were similar to those which now exercise the same influence on the climate of Canada.

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* 'Quarterly Journal of the Geological Society,' vol. xvii. pp. 31 and 34.

† 'Geological Magazine,' vol. iii. p. 385. September, 1866.

‡ Reprinted, nearly entire, in the 'Geological Magazine,' vol. iii. p. 457. October, 1866.

Amongst the facts which have been relied on as most clearly proving the vast extension of the Alpine glaciers during the glacial period, none have been regarded as more certainly the result of that icy development than the occurrence of erratic blocks of Alpine rocks on the mountains of the Jura, which has been held by most geologists to demonstrate that the Alpine glaciers formerly extended to the Jura range. M. Sartorius von Waltershausen, the distinguished Professor of Geology at Göttingen, however, has lately, in his prize-essay crowned by the University of Haarlem,* advocated the theory that the Alpine glaciers terminated in an inland sea or lake, where they formed icebergs, some of which, floating towards the Jura, deposited their burdens on that shore. The publication of this work has called forth an able review† from the pen of Professor B. Studer of Berne, in which Professor von Waltershausen's theory is shown to be inconsistent with positive facts, and to be rendered extremely improbable by negative evidence. Most geologists, however, will no doubt read the arguments on both sides with pleasure and profit, for although this theory is probably not applicable to the particular case of the Alps and the Jura, the possibility of its being the true explanation of the phenomena observed in other regions should not be lost sight of by those who prefer simple truth to the universal triumph of a pet hypothesis.

In the number of the "Bulletin de la Société Géologique de France" for September, M. Gaudry gives the results of his long and laborious examination of the fossil mammals of Pikermi. His paper is short, and will well repay a careful consideration; but we can here only mention one of the points he brings forward, namely, that the facies of the Pikermi fauna is altogether African. M. Gaudry recommends this fact to the notice of geologists who investigate the history of the Tertiary period; but it is equally important in its bearings on the origin of the recent African fauna,‡ and is thus worthy the attention of those naturalists who are at present endeavouring to unravel the tangled web of affinity which forms the connection between the recent and fossil faunas of different regions.

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* Untersuchungen über die Klimate der Gegenwart und der Vorwelt.

† 'Recherches sur les climats de l'époque actuelle,' &c. Bibliothèque Universelle, September, 1866.

‡ See 'Quarterly Journal of Science,' No. II., p. 213; No. IV., p. 648; and No. X., p. 169.

The last number of the 'Natural History Transactions of Northumberland and Durham' contains a short paper by Mr. H. B. Brady "On Casts of Palæozoic Corals found amongst the Refuse of Alkali Works," which possesses considerable interest for those who investigate the means by which fossilization is produced. The specimens consist of siliceous casts of the calcareous skeletons of certain corals, and they were so completely decalcified by the process for the generation of carbonic acid, to which they had been submitted, that they remained unaltered on a second maceration in strong acid.

The contents of the 'Geological Magazine' during the past quarter have been so important that our brief notice of them here must not be regarded as at all exhausting the subjects which are brought before us in the several papers that the numbers contain. In the first place we must notice the conclusion of Dr. Lindström's paper on the Rugosa, in the September number; but we can only summarize the conclusions at which the author has arrived, namely, (1) "that *Goniophyllum pyramidale* is an undoubted *Zoantharia rugosa*, ... and that it coincides with the three species of the genus *Calceola*," which must therefore be removed from the class *Brachiopoda;* (2) that the *Rugosa* must be separated from the *Actinozoa*, and must form a class of their own in the great division of Radiated animals. Dr. Lindström, indeed, accepts Professor Agassiz's opinion that the *Rugosa* are related to the living *Lucernariæ*. It cannot be said that there is much evidence in support of this supposition, and we should be rather inclined to seek for the affinity of these aberrant corals in a higher rather than in a lower direction; but, however the case may ultimately be decided, Dr. Lindström's is a most valuable and welcome contribution. In the November number is a paper on a kindred subject, by Mr. H. A. Nicholson, who has discovered in the Moffat shales, Dumfriesshire, certain structures associated with Graptolites, which he interprets to be external organs of reproduction, and therefore corroborative of Professor James Hall's opinion of the Sertularian nature of the *Graptolitidæ*, and to disprove the prevalent opinion of their Bryozoan affinities.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

It would be quite useless, in this Chronicle, to endeavour to give an abstract of all the papers, thirty-three in number, contained in the last number of the Society's journal. We shall, therefore, select a few of the more interesting and important communications, more especially as several of the others are of too technical a nature to be dealt with here.

In the first paper in the Journal, Mr. Boyd Dawkins grapples with the question of the origin of our domestic races of cattle, which he believes can only be solved by a careful examination of each of the three European fossil animals, namely, (1) the great Urus, *Bos Urus* of Julius Cæsar; (2) the small Short-horn, *Bos longifrons* of Professor Owen; and (3) the Bison, *Bos bison* of Pliny. He confines himself now to a consideration of the Urus, and after a careful statement of the historical evidence on the subject, he infers that this animal "probably lingered in the wilder parts of continental Europe till at least the sixteenth century."

Mr. Whitaker's paper "On the Lower London Tertiaries of Kent," deserves especial notice, on account of its value as a contribution to systematic Geology. Hitherto, over the whole of the London Basin, Mr. Prestwich's classification has been adopted, namely, in descending order, (1) Basement-bed of the London Clay; (2) Woolwich and Reading series; and (3) Thanet Sands. Mr. Whitaker shows that the beds of East Kent (Upnor, Reculvers, &c.), until now considered identical with the Basement-bed of the London Clay at Lewisham, &c., belong to a lower series, intermediate between this Basement-bed and the Woolwich and Reading series. To this new division he gives the name Oldhaven Beds; and he refers to it also the pebble-bed of Blackheath, Abbey Wood, &c., which have been referred to the same division as that of Lewisham, as well as some sandy pebble-beds in West Kent, hitherto considered to form part of the underlying Woolwich and Reading series.

The paper is extremely valuable for containing so many facts bearing on the changes of the various members of the divisions of the Lower London Tertiaries, in passing from east to west. We will just mention one instance. The only constant portion of the Thanet Beds is its lowest member,—the base-bed. In West Kent this is succeeded by the thick mass of unfossiliferous sands so familiar to metropolitan geologists; these sands, however, thin out towards the east, until, near Canterbury, they entirely disappear; and the base-bed is then succeeded by a band of loamy clay, which thins out towards the west beneath the member just noticed. But in the eastern division of Kent, the bulk of the Thanet Beds consists of two fossiliferous members, neither of which extends farther east than Rochester, beyond which the series is entirely represented by the base-bed and the great mass of unfossiliferous sands already noticed. Here, therefore, is the explanation of the fact that fossils are found in one district and not in the other,—the beds are not the same, as has hitherto been supposed.

Geologists seem to have accepted with passive submission, and with one accord, Mr. Prestwich's conclusions as to the relative ages of the valley-gravels of the Somme, the Ouse, and other rivers; but whether this docility has resulted from supineness or conviction we cannot undertake to pronounce. Mr. Tylor, however, seems to think that this state of things has lasted long enough, and in a paper "Upon the Interval of Time which has passed between the Formation of the Upper and Lower Valley-gravels of part of England and France," he endeavours to show that the value of this interval is nothing, and that the two sets of gravels are of the same age. He explains and illustrates this view by stating his belief, that the valleys themselves are of very ancient date, that subsequent to their formation they were entirely filled with gravel, and that more recently still the valleys have been re-excavated, leaving at different heights patches of gravel which have escaped being washed away. Mr. Tylor endeavours to explain the history of the valley of the Somme on this supposition, by reference to the valleys of Devonshire, just as Fluellin argued, "there is a river in Macedon; and there is also, moreover, a river at Monmouth" . . . . "and there is salmons in both."

The tendency of geological opinion on the subject of metamorphism has of late years been in favour of ascribing that pheñomenon to hydrothermal action; but for the evidence in support of this theory, geologists are almost entirely indebted to chemists and mineralogists, the geological data in its favour being very scanty, and more or less vague. We have now, however, to chronicle the publication of a most important paper by Mr. J. Geikie, "On the Metamorphic Lower Silurian Rocks of Carrick, Ayrshire," which contains a generalized description of certain felspathic, dioritic, serpentinous, and calcareous rocks, treated with a view of ascertaining what evidence they may yield bearing on the cause of their metamorphism; for it is shown that these are all metamorphic, not igneous, rocks in this region. In Mr. Geikie's own opinion, the details seem to prove:—"(1) That the strata owe their metamorphism to hydrothermal action. (2) That the varying mineralogical character of the rocks is due principally to original differences of chemical composition, and not to infiltration of foreign matter at the time of metamorphism. (3) That the highly alkaline portions of the strata have been most susceptible of change. (4) That in beds having the same composition, but exhibiting various degrees of alteration, the intensity of the metamorphism has been in direct proportion to the amount of water passing through the strata. (5) That in some places the rocks have been reduced to a softened or pasty condition."

A paper "On the Structure of the Red Crag," by that veteran palæontologist, Mr. S. V. Wood, sen., contains an entirely new view (so far as we are aware) of the succession of life in those deposits which are grouped under the name of Red Crag. No man is so well qualified to write on this subject as the author of this paper, who has spent most of his life in the thorough investigation of the Crag deposits; his inferences are therefore entitled to more than ordinary consideration.

Within the last few months, Geology has suffered from the loss of several of her followers; amongst them Mr. C. Maclaren, author of 'The Geology of Fife and the Lothians,' and Mr. Alexander Bryson, were men of local eminence. Don Casiano di Prado was the leading geologist of Spain, where his death will be severely felt by his small band of associates; and M. Louis Saemann, who was at the same time an accomplished mineralogist and a liberal-minded dealer in minerals and fossils, will be regretted by a large circle of friends and customers; for he was the most enlightened, most liberal, and most enterprising of all dealers; and by his death Geology has therefore sustained a severe blow of a most peculiar nature. But however much we may regret these losses, they are trifles compared with that caused by the death of Mr. William Hopkins, of Cambridge, for by this sad event it seems as if our science were deprived of a limb, this distinguished man being the founder and only master of what may be termed Mathematical Geology.

10. MINING.

At the time when there is something more than indications that the Cornish copper mines are giving symptoms of exhaustion, we hear of the extraordinary development of copper mines in California. Fifteen counties, from San Diego to Del Norte, possess veins of copper, which will give, it is said, at least 10 per cent. of metal. The cost of transit so largely interferes with the development of those mines, that those only which are at a short distance from San Francisco are worked. Amongst those the Union Mine at Copperopolis has lately exported 110 tons of ore a-day, of which 50 tons contained 20 per cent. of metal. Notwithstanding the value of this ore, the cost of carriage absorbed nearly all the profit. Attempts have been made—and considerable success has attended them—to smelt the ores near the place of production, and we are told that cakes of copper containing from 90 to 95 per cent. of copper are obtained. Allowing for some exaggeration, there appears to be no doubt that immense deposits of copper exist in California, and that in a few years, when roads have been constructed, these will be extensively and profitably worked.

After the remarks which we made in our last, on the depressed state of mining in the British Isles, the above does not encourage the hope of any great improvement in the condition of our copper mines. Tin mining is rather more encouraging, for, although at the present prices of that metal, the mines cannot make a profit, there is a prospect that the price will shortly improve. The Dutch candidly state that they cannot continue to import the tin from Banca and the Straits at the present low scale of prices. From some cause or other, not satisfactorily explained, there has been for some time, a gradual falling off in the quantity of tin produced in Banca. At present the supply of tin is considerably in excess of the demand, and with the depression which pervades every branch of metal manufacture, there is no immediate prospect of any large quantity of tin being consumed. But with a revival of trade, so important a metal must again be largely in demand, and the immense stores of tin existing in Cornwall may then be worked to advantage.

It is satisfactory to know that the Cornish miners are finding employment at home, instead of abroad. Nearly a thousand of these industrious men are now supplying the places vacated by the colliers on strike in Scotland, and many more are finding employment on the railways. These will, therefore, be available as soon as an improved market renders it prudent to work the Cornish mines with greater activity.

We have no discovery to chronicle this quarter in any of the mining districts of Great Britain or of the Continent.

It was formerly a notion amongst miners that tin could only exist near the surface of the earth, and many mines were abandoned, because, as the miners said, "tin never made in depth." At length, energy dissolved this theory, and now the largest quantities of the finest tin are obtained from the deepest mines of Cornwall. A similar superstition prevails respecting the deposition of gold in quartz lodes. The gold miners will tell you that gold falls off in depth. This hypothesis appears destined to share the fate of that relating to tin.

Mr. A. Hayward, of Sutter Creek, Amadas Co., California, is working a quartz lode to the depth of 1,200 feet, not less than 300 feet below the sea level. The result is, in this instance, that the quartz vein increases in width and value in proportion to depth. The quantity of gold obtained from this mine has been to the value of six or seven million dollars, and in the galleries already opened gold quartz is standing which is valued at, at least, two million dollars.

MINERALOGY.

The Rev. Samuel Haughton has published* his examination of a meteoric stone which was seen to fall at Dundrum, Co. Tipperary,

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* Royal Irish Academy, 1866. 'Philosophical Magazine,' No. 216, p. 260.

Ireland, on the 12th August, 1865. This stone was given by the observer and finder, John Johnson, of Clonoulty, to Lord Hawarden, and presented by his lordship to the Geological Museum of Trinity College. Professor Haughton has determined its composition to be:—

	per cent.	
Nickel Iron . . .	20·60	19·57 Iron 1·03 Nickel
Protosulphuret of Iron .	4·05	
Chrome Iron . . .	1·50	
Mineral soluble in Muriatic Acid, probably Chrysolith .	33·08	
Minerals insoluble in Muriatic Acid .	40·77	
	100·00	

There can be no doubt but that this is a true meteoric stone, its composition agrees so closely with that of others. The "statement by an eye-witness," who says, "I heard a clap like the shot out of a cannon, very quick and not like thunder; this was followed by a buzzing noise, which continued for about *a quarter of an hour*, when it came over our heads, and on looking up we saw an object falling down in a slanting direction," &c., &c., is rendered of very uncertain value by the exaggerations contained in it.

The "Colorado Meteorite," as it is called, which is stated to have been found in "Russel Gulch, Feb. 18, 1863, by Mr. Otho Curtice," weighs 29lbs. It has been examined by Professor J. Lawrence Smith, of Louisville, and its composition found to be:*—

Iron	90·61
Nickel	7·84
Cobalt	·78
Copper	a trace
Phosphorus	·02
	99·25

Gay-Lussite has been found by Professor B. Silliman in great quantities at the Little Salt Lake, near Ragtown, Churchill Co., Nevada. These crystals have been examined by Mr. John M. Blake, who shows that in crystalline form these specimens differ in some respects from such as have been previously measured.†

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* 'Silliman's American Journal of Science and Arts,' No. 125 p. 218.
† Ibid., pp. 20, 21.

F. Wohler, continuing his examination of *Laurite*, arrives at the conclusion that it is a native sulphate of ruthenium.[*]

In the 'American Journal of Science and Arts,' Mr. Charles Upham Shepard continues his mineral notices. A new mineral, *Hagemannite*, so called—in obedience to the absurd fashion of naming minerals after some one who may have had something to do with the specimens in question—after Mr. G. Hagemann, chemist to the Natron Chemical Works, Alleghany Co., has been brought from Arksutfiord, Greenland. It appears to be a very complicated substance. Mr. Shepard says:—"The deduction of a formula is difficult. The following is suggested:—

$2\,(\mathrm{Ca} + \tfrac{2}{3}\,\mathrm{Na} + \tfrac{1}{3}\,\mathrm{Mg})\,\mathrm{Fl} + (\tfrac{3}{4}\,\mathrm{Al} + \tfrac{1}{4}\,\mathrm{Fe})\,2\,\mathrm{Si\,Fl} + 2\,\mathrm{HO}$."

The notices of the discoveries of *Cotunnite*, *Columbite*, and *Spodumene* in new localities are unimportant.[†]

M. Edmond Becquerel has published a paper, "On the Phosphorescence of Hexagonal Blende."[‡] The subject belongs to Physics proper, and it is therefore mentioned in this place for the purpose of recording it, and directing the attention of our readers to some optical phenomena of much beauty.

Mr. E. J. Chapman, of Toronto, has announced [§] the discovery of native lead on the north-west borders of Lake Superior. It will be remembered that in our last number we mentioned the discovery of this rare native metal in Australia. Mr. Chapman states that the lead of the Lake Superior district having been cut, presents the colour, the softness, and the ductility of the pure metal. It is not generally known that specimens of native lead were found some years since by Mr. Stephen Eddy, in the mines of Grassington, belonging to the Duke of Devonshire, in Yorkshire.

The Secretary of the Imperial Society of Mineralogy, of St. Petersburg, announces that the Society will celebrate, on the 7th January, 1867, their fiftieth anniversary, and invites the learned of all countries to take part in this celebration.

M. Fremy read on the 20th of October, in the Académie des Sciences of Paris, a note on "*Une méthode générale de cristallisation.*" This note was published in 'Les Mondes,' with but slight omissions, and from its importance we reproduce it from that periodical.[‖]

"I have thought," says M. Fremy, "that if I could slowly effect the precipitations and decompositions which render bodies amorphous, because they are instantaneous, I should place myself in the same conditions as nature, and that I should obtain, in a crystallized state, bodies which instantaneous precipitations rendered amorphous. For this purpose I first introduce two bodies which react on each other in liquids of different densities, containing gum, sugar, or gelatine. Then I separate them by beds or partitions of porous bodies, such as wood, unglazed porcelain, &c., or by leaves of unsized paper, which in imbibing them, little by little, renders the decomposition slow, and nearly always produces crystallized bodies. The porous vessels allow the liquid which they contain to run out very slowly, and often produce beautiful crystallizations, which are found in the interior of the vessels when the liquid has left them. I have thus obtained insoluble bodies in a crystallized state, and often of very perfect forms, such as sulphate of barytes, sulphate of strontian, carbonate of barytes, borate of barytes, chromate of barytes, magnesia, sulphur, &c. This method appears to me very generally applicable. I have tried to apply it to the alkaline silicates, by submitting them to the action of certain acids, in porous vessels, with the hope of obtaining quartz or crystallized silica, which is so common in nature. Slowly decomposing, they have formed white crystalline masses hard enough to scratch glass. I hoped to achieve the production of real quartz, but the crystals dissolved in the alkaline liquids, and they were highly hydrated. There were silicates of soda, containing—silica, 68; soda, 5; water, 29. The proportions of silicate and water being the same as in $Si\,O^3, 2\,H\,O$. These experiments confirm the provisions of our illustrous confrère, M. Chevreul, who, to explain the presence of oxalate of lime in certain plants, supposed that a soluble oxalate slowly traversing the coating of a vegetable cell, or of a bundle of fibres, could react on a calcareous salt, found in a cavity, and give birth to crystallized oxalate of lime. I believe I can say, in conclusion, that the method which I have published will permit all bodies which are found crystallized to be artificially reproduced, whether in the earth or in organic tissues, and consequently that it will afford us much useful knowledge respecting their modes of production."

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[*] 'Archives des Sciences' (Bibliothèque Universelle), vol. xxvi., No. 102, p. 146.

[†] 'The American Journal of Science and Arts,' No. 125, 1866.

[‡] 'Les Mondes,' 29th Nov., 1866, p. 521.

[§] 'American Journal of Science,' L'Institut. 14th Nov., 1866, p. 368.

[‖] 'Les Mondes,' 1st Nov., 1866, p. 392.

Minerals in Spain.—Attention has again been drawn to the natural phosphate of lime, which exists in many parts of Spain. The deposit which is now attracting attention is one stated to have been discovered by M. de Luna, near Merida, in the centre of the Estremadura. As far back as 1844, however, Dr. Daubeny, in company with Captain Widdrington, explored this district. Dr. Daubeny then stated the composition of this phosphorite rock to be about 80 per cent. of triphosphate of lime, and 14 of fluoride of calcium. From that time until now, no use has been made of this; but, probably, now that a railway is brought near he locality in which it exists, it may be found commercially valuable. M. de Luna has forwarded samples of this native phosphate to the Academy of Sciences, and he proposes to convert it into the acid phosphate of lime, at a low cost, by means of the sulphurous acid of Almaden. M. Chevreul has recently published a paper "On the Estremadura Phosphate."*

New Zealand Gold.—The total export of gold from the province of Otago since 1861, when this gold field was discovered, to the end of 1865, was 1,875,053 ounces, and from the commencement of this year to the latest return from the colony, 69,784 ounces have been exported.

Many of the coals and coal-measure shales of New South Wales are now being actively worked for the production of petroleum, or kerosene, as they more generally term this oil in the colony. At Hartley nine retorts are in action, and they are producing 1,200 gallons a-week. The refining power now established is said to be equal to 10,000 gallons a-week. To produce this, 100 tons of the cannel coal found at Hartley is necessary; but, we are told, a single acre of this coal will furnish mineral enough for a year's supply at the rate of 100 tons a-week.

METALLURGY.

We ought not to lose sight of the fact, that during the period of depression of our iron trade, there has been great activity in the iron works of Belgium. The production of pig-iron in the district of Charleroi has been, during this year, about 500,000 tons. Of this 10,000 tons have been exported, while 25,000 tons of pig-iron have been imported. Nearly all the Belgium pig-iron is now worked up in the country, and is exported only as malleable iron. Belgium, in 1865, exported 57,000 tons less, and imported 120,000 tons more, than in the preceding year.

Barytes white (sulphate and carbonate of baryta) has been long used for the adulteration of whitelead; and, for this purpose, it is still employed to an extent which is disgraceful. It is now, however, used for the enamel upon visiting cards, and on paper. Especially does it find a use in the manufacture of paper collars; and we learn that twenty tons of sulphate of baryta are used per day in the paper-collar manufactories of New York city alone.

H. Fleck continues his inquiry "On the Characteristics of various Kinds of Coal."† De Bergne has published an account of what he considers an improved blast furnace. Experience is, however, necessary before it can be pronounced to be an improvement. Messrs. Sparrow and Poole, of Ffrwd, in North Wales, have constructed a furnace with more permanent arrangements than usual for taking the gases from the top. The arrangements appear very complete. When the furnace is blown in we hope to describe it.

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* 'Comptes Rendus,' vol. lxiii., p. 402.

† 'Dingler's Polytechnisches Journal,' vol. 181, p. 43.

"On the Dissociation of Gases in Metallurgical Furnaces," by L. Cailletet, should be consulted.

An improvement is said to have been made by Mr. Forster, at the well-known Lead Hills Mines, on the ore-hearth—or what is well known to lead smelters—as the Scotch furnace. The advantages are reported to be, that—

1st. The improved hearth can be worked continuously. The importance of this fact will be patent to every lead smelter, when he remembers that the ordinary mode of working with the Scotch furnace involves a separate lighting and heating every day,—the heating and fusion of the *browse* of roasted and agglomerated ore requiring an hour, at least, for each new operation. By using the improved hearth there is thus great economy both as to fuel and men's time.

2nd. No peats are required in the new hearth, at least, that is the experience of Mr. Forster at Leadhills.

3rd. Since the improved hearth has got into regular working order, it has given a return of lead four per cent. greater than is yielded by similar ore reduced in the old form of hearth.

Mr. Nevin, the manager at Lead Hills, has furnished us with sufficient data to make the following contrast of the expense of obtaining a ton of lead:—

In the Unimproved Hearth.

	s.	*d.*
Wages	7	6
Coals, 2 cwt. at 8½*d.* ..	1	5
Peats, 2 loads at 5*d.* ..	0	10
Lime, ½ cwt. at 10*d.* ..	0	5
	£0 10	2

In Forster's Improved Hearth.

	s.	*d.*
Wages	6	1½
Coals, 1¼ cwt. at 8½*d.* ..	0	10½
Peats, none	0	0
Lime, ½ cwt. at 10*d.* ..	0	5
	£0 7	5

Mr. Nevin thus argues as to the economical working of the improved hearth:—Suppose a smelt-mill to produce 2,000 tons of lead yearly, there would thus result in wages and fuel alone a clear annual saving of 275*l.*

This large saving has been questioned by correspondents in the pages of a contemporary journal, but the objections urged have been fairly met, and we have no reason, at present, to doubt their correctness.

Those who are interested in this metallurgical process, should consult a short paper by A. Habets,[*] "On the Smelting of Lead in the Raschette Furnace as used in the Upper Hartz."

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[*] 'Revue Universelle des Mines,' vol. xix., p. 37.

Mr. D. Kirkaldy has published some good practical remarks on the influence of repeated forging on the strength of wrought-iron.*

11. PHYSICS.

Light.—The spectral analysis of the light of the stars has been followed up unremittingly by many observers. Amongst others, Father Secchi has published some generalizations: he divides the Stellar spectra into three types.

The first and most dominant type is that exhibited by white stars, such as Sirius. Their characteristic is a black band in the green-blue, and a second band in the violet.

Half the visible stars belong to this type. Two remarkable exceptions have been found, the stars γ Cassiopeiæ and β Lyræ. These are perfectly complementary to the type, and instead of having a dark ray in the green, have a luminous band. Another modification of this type is presented by the constellation Orion (α excepted), which has no large bands, and in which the violet lines are very difficult to see. The second type consists of stars having coloured bands in the red and orange. The most remarkable and typical star of this class is α Hercules, the spectrum of which has the appearance of a series of columns illuminated from one side; the stereoscopic effect of the convexity of these bands, due to the shading, is so surprising, that it cannot be beheld without astonishment. The third type consists of stars giving fine lines: it includes Arcturus, Capella, Pollux, &c., and also our own sun. The author says that the spectra of these stars perfectly resemble that of the sun, with fine lines in the same places. In these stars may be seen the principal solar rays, B, D, *b*, E, F, G, and a great many secondary rays.

As a proof of the existence of iron in the solar atmosphere, M. A. J. Ångström has compared the solar spectrum with one formed by two iron electrodes, with a battery of 50 elements, and has found more than 460 rays corresponding to the lines of iron. Two observations which the author has made are of interest: one is the certain presence of manganese in the sun, proved by the coincidence of nearly thirty lines; and the other is the discovery of a new ray of hydrogen, situated nearly half way between G and H, and which M. Angström calls *h*.

An addition, which may prove important, has been made to our knowledge of the obscure subject of right- and left- handed polarization.

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* 'Deutsche Industriezeitung,' No. 82. 'Organ für die Fortschritte des Eisenbahnwesens,' New Series, vol. iii., p. 178.

M. Gerney has discovered that a supersaturated solution of left-handed double tartrate of soda and ammonia does not crystallize in contact with a fragment of the same salt right-handed, and *vice versâ*. From an inactive supersaturated solution of double racemate of soda and ammonia, a fragment of right-handed crystal determines only the precipitation of right-handed crystals; whilst a portion of the same liquid, in contact with a left-handed crystal, produces a deposit of the left-handed salt.

This supplies a simple means of separating at will from the double racemate of soda and ammonia, either of its two constituent salts.

M. Niepce de Saint Victor is perseveringly continuing his experiments on the photographic reproduction of colours. He has now succeeded in preparing a silver plate, on which all the colours, and even white and black, are capable of being impressed in the camera. His sixth memoir, which has just been communicated to the Academy of Sciences, contains several improvements in detail, principally with the view to obtain good blacks.

A memoir has been published by M. E. Reichert, on the different refractive powers of fluids, modified by their chemical composition. It contains the results of experiments on solutions of common salt of different strengths, and the proportions of salt shown by optical means and by ordinary analysis agree very closely. An equally satisfactory result was obtained by solutions of sugar; but with alcohol and acetic acid, the differences in the refractive indices are only half as great.

The refraction- and dispersion- equivalents of chlorine, bromine, and iodine, have been examined by Dr. Gladstone, and by him communicated to the British Association. The refraction-equivalent of the substance is the product of its atomic weight with its specific refractive index—that is, its refractive index minus one, divided by its density. Its dispersion-equivalent is the difference between the refraction-equivalents as calculated for the two extreme lines of the spectrum, A and H.

From the determinations which Dr. Gladstone has made in conjunction with the Rev. T. P. Dale, it is seen that in each case the number for bromine lies between those for the other two. The refraction-equivalents are, for chlorine 9·8, for bromine 15·5, and iodine 24·2, and the dispersion equivalents are, for chlorine 0·5, bromine 1·3, and iodine 2·6.

HEAT.—In experiments on radiant heat with the thermo-electric pile, M. P. Desains proposes the employment of a differential apparatus, consisting essentially of a single source of heat, of two thermo-electric piles, of a double-wire galvanometer, and finally of a rheostat. The apparatus is so arranged that the equilibrium, once obtained, remains uniform, however the heat from the source varies; but if the smallest variation takes place in one of the radiations, the needle quits the zero point. The author has applied this apparatus to the examination of the absorption of heat by transparent gases, and finds that it gives very delicate and certain indications. This may be the case, but we do not see that the arrangement described by M. Desains is superior to Wheatstone's Bridge, the construction of which is peculiarly simple and easy, whilst the correct adjustment of a double wire differential galvanometer is a most difficult and uncertain operation.

The chemistry of the galvanic battery is a subject which would seem to have become almost exhausted. M. Favre has, however, contributed some important experiments, in which he has examined the amount of heat set in motion during galvanic decompositions or combinations. The conclusions at which he arrives are, that when a body is decomposed by the battery, the constituent elements, in separating, absorb a larger amount of heat than they disengage again in combining under ordinary circumstances. Thus, in the nascent state, bodies possess an excess of heat, which they give up on becoming modified to the ordinary state. The author's experiments reveal another fact,—that secondary actions take place in the battery, accompanied by a disengagement of heat, which is not turned to account in the current, and therefore he says that electro-magnetic machines cannot dispose of all the heat set in action in the battery.

M. de Gernez has investigated the subject of the disengagement of gases from their supersaturated solutions (of the soda-water type) and has discovered the following facts:—1st. Solid bodies, from which the gaseous bubbles are disengaged, lose their property after a certain time. 2nd. Prolonged soaking in water also removes this action from them, 3rd. Heat has the same action. 4th. Solid bodies, which have been in contact with air, have no action on supersaturated gaseous solutions. 5th. Air and gases provoke the disengagement of dissolved gas.

Electricity.—Electricity, although the youngest of the sciences, has already produced such marvellous results that some knowledge of its principles must, in future, form part of a liberal education. To impart this knowledge in a concise form has been the aim of Doctor Noad in his 'Text Book of Electricity.'* Of course, in a work of this sort, much originality is not expected, nor, indeed, would it be considered so desirable as a judicious selection, from acknowledged authorities, of those facts which form the groundwork of the science, and the truth of which has been universally admitted. This has been the course adopted by Doctor Noad in the present work, and the result is eminently satisfactory, including as it does, within the limits of a moderate-sized volume, all the information necessary to make the student acquainted with the present state of electrical science, as well as with the successive steps by which the knowledge has been obtained. Throughout the book extracts are freely inserted from such works as the report of the committee 'On the Construction of Submarine Cables,' the 'Cantor Lectures' of Mr. Fleeming Jenkin, and especially from the beautiful 'Experimental Researches" of Professor Faraday, with which every student of the science should be familiar. Of late years the practical applications of electricity have naturally received more attention than the theory of the science, and thus we find that, while very few important laws are of recent discovery, the branch relating to electric telegraphy, and more especially to submarine cables, has immensely advanced. Most of this advance is due, not so much to the discovery of new principles, as to the better application of those already discovered, and almost the whole of the present system of testing may be said to be based upon two of these, *viz.* Ohm's law, and the law of derived circuits. The former is expressed by the formula

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* 'The Student's Text-Book of Electricity.' By Henry M. Noad, Ph.D., F.R.S., F.C.S., &c. London: Lockwood & Co.

$$C = \frac{E}{R},$$

in which equation the current circulating, the electromotive force of the battery, and the resistance of the circuit, are connected together: while the latter law is simply this, that if two paths are open for the electricity to travel by, the quantity circulating in each will be inversely as the resistances of the two branches. Wheatstone's bridge, or the electric balance, is one of the most ingenious and valuable applications of these laws; by its means the resistance of any circuit may be found in terms of a known resistance. A very clear description of this invention, and the principles on which it is based, is given in the 'Text Book.' Most of the information contained in the "Cantor Lectures," delivered by Mr. Fleeming Jenkin at the Society of Arts, will be found here in a condensed form, together with a full description of the improved galvanometers and electronometers invented by Sir William Thomson.

Turning from the scientific to the popular side of electricity, as exemplified by the induction coil, we find that here also progress has been chiefly in the direction of improved arrangement and manufacture. In Dr. Noad's treatise on this instrument,* much of the superiority of the modern coils is ascribed to the improved form of contact-breaker introduced by Mr. Ladd, which allows the iron to attain to the maximum of magnetization before the current ceases. The static effects of the secondary current are also largely increased by the use of a condenser, as suggested by M. Fizeau, although the principle of its action is by no means clearly understood. Dr. Noad's 'Inductorium' gives a complete description and explanation of these instruments, together with a number of scientific and popular experiments which may be made with them. The 'Small Induction Coil'* by J. H. is a description of the cheaper forms of coils which have lately become so popular. Without attempting an explanation of their principles, the author contents himself with showing their construction, and the purposes to which they may be applied; and, for the majority of purchasers of these instruments, his pamphlet will, we think, be found sufficient.

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* 'The Inductorium, or Induction Coil.' By Henry M. Noad, Ph.D., F.R.S., F.C.S., &c. Second edition. London: Churchill & Sons.

Some very valuable researches on the propagation of electricity in highly-rarefied elastic fluids, and on the stratifications of the electric light which accompany this propagation, have been published by M. A. De la Rive. The author has introduced a novel method of research, which appears capable of throwing considerable light on these obscure phenomena. He takes a large glass globe, furnished with four tubulures, having leather stuffing-boxes traversed with metallic rods. Two of these are connected with a powerful Bunsen's battery, and the voltaic arc is produced between them. The other two rods are intended for the passage of an electric current from an induction coil. The voltaic arc is simply used as a source of heat to fill the exhausted globe with metallic vapours, and the phenomena which the author has investigated, are those produced by the passage of the induction current through this metallic vapour. The globe is first well exhausted, and then filled with nitrogen, which is rarefied to two or three millimetres' pressure, the induction-current is then turned on, and the Bunsen's battery is connected with the other rods, so as to produce a voltaic arc. In a few minutes the intensity of the induction-current augments considerably, and its colour alters according to the nature of the points between which the voltaic arc is formed. With points of silver or zinc the light is of a decided blue colour; with copper, the tint is very deep green; with cadmium, apple-green; with magnesium, light green; and with aluminium, greenish white. In a second part of the paper the author studies the stratifications of the electric light, which he considers to be a phenomenon analogous to the production of sonorous waves. The third part is devoted to a discussion of particular phenomena which different parts of the electric stratification present. He compares these phenomena to those observed when a voltaic current of a certain strength is passed through a chain composed of alternate links of platinum and silver. The author proves, in an ingenious manner, that the dark spaces of the stratifications conduct electricity better than the luminous portions. He also shows, by thermometric observations, that the temperature of the luminous is more elevated than that of the dark portions.

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* 'A Popular Description of the Small Induction Coil, with a Variety of very Beautiful and Instructive Experiments.' By J. H. London: Varty & Cox.

An improvement has been made by M. Bertsch on the somewhat celebrated electric machine of Holtz. The machine is too complicated to allow of description in abstract. With a disc of vulcanite, 50 centimetres diameter, sparks of about 15 centimetres long can be obtained at the rate of from five to ten a second, and having sufficient tension to pierce a glass one centimetre thick, and to illuminate continuously a tube of rarefied gas one metre long. In thirty or forty seconds it will charge a battery having an interior surface of two square metres, which will burn up a thick iron wire one metre in length.

The subject of thermo-electricity has lately attracted much attention. Our knowledge has now been considerably enriched by an elaborate memoir by M. Becquerel on the thermo-electric powers of different alloys, and the construction of thermo-electric batteries. For thermo-piles for low temperature, he recommends an alloy consisting of equal equivalents of antimony and cadmium with one-tenth the weight of bismuth, for the positive metal, and an alloy of ten of bismuth and one of antimony for the negative metal. For piles of a high tension the negative metal should be German silver, and the positive may be either the above antimony, cadmium, and bismuth mixture, or fused and annealed sulphide of copper; the latter stands the greatest heat, but gives also the highest resistance. As sulphide of copper is a very bad conductor of heat, it will scarcely be found necessary to cool the other ends; but this should be done when a metal is used, and the length of the bar should, in that case, be increased. Thermo-electric piles, on account of their low tension, cannot yet replace hydro-electric batteries; but, for special purposes, and particularly for the study of radiant heat, the piles here described offer new facilities, and are, therefore, worthy of attention.

M. Zaliwski-Mikorski has introduced an improvement in the method of filling and emptying the troughs of galvanic batteries of two liquids, such as Groves's or Bunsen's. The permanent part consists of an alternate succession of porous diaphragms and isolated carbons. By means of tubes in the lower part, a liquid poured into one compartment immediately flows into all the analogous compartments; the whole of them can also be emptied simultaneously with a syphon.

The trough, therefore, need not be moved when it has to be filled or emptied. The zincs, which are loose, rest on the carbons, which project for this purpose at their base; and the effect of removing one, or more, is not to stop, but only to diminish, the intensity of the current. The cement which is most recommended, is one consisting of sulphur, rendered less brittle by a mixture of tar and lampblack.

12. ZOOLOGY AND ANIMAL PHYSIOLOGY.

MORPHOLOGY.

The Skull.—The expression "theory of the skull and vertebrate skeleton," which is now very frequently used, certainly requires a little explanation before the ordinary mind can perceive the meaning it is intended to convey. When a theory of the origin of species is spoken of, we clearly understand what is meant, for we are accustomed to discuss theories of the origin of various other things, besides species; but a "theory of the skull" may relate to its origin, to its use, or to any one of its functions. Mr. Harry Seeley, in a very clever paper on this subject, prefaces his remarks by stating that by a theory of the skull, he means a way of presenting a set of well-known facts, so that they explain themselves. This is really what is meant by Professor Owen when he advances his theory of the skull, and by Professor Huxley when he advances his. Mr. Seeley puts forward a view of the facts known concerning the vertebrate skull, which causes these facts to explain themselves in a way which does not impugn the fundamental truth of the views of either of the two great comparative anatomists, but is in a certain way an attempt to find the truth which lives in both, and is an exceedingly ingenious and interesting essay.

The final conclusion of Mr. Seeley's theory is,—"That the skull is the terminal segment of the body, and that just as the adjacent segments consist of the pharynx, the larynx, and a vertebra enclosing part of the neural column, so also the skull, which is the termination of these three organs, and where their outlets are visible, must consist of them also; that the brain-case, therefore, (the termination of the *neural* system), is a modified vertebra, that the bronchial circle of nasal and palatine bones is a modification of the trachea, and that the lower jaw is a modified rib developed by the mouth. The respiratory circle of bones is the key to the skull."

Races of Men.—M. de Quatrefages has brought out a work on anthropology, entitled, 'Oceanic Races: the Polynesians and their

Migrations.' He follows chiefly the conclusions of the American writer, Mr. Horatio Hall, and adduces evidence that the Polynesians have not been created by nation and on the spot; they are by no means a spontaneous production of the isles on which they are found, nor are they the remnant of a pre-existing population partly destroyed by some cataclysm. Whatever the origin of the islands may be, their inhabitants came there by voluntary migration, or by involuntary dissemination, successively, and advancing from west to east. They set out from the Oriental Archipelago of Asia, have migrated from island to island, and are yet doing so. The earliest migration was probably not antecedent to the Christian era. The race contains mixtures of the black, white, and yellow races, in which the last is least prominent. The author determines, in some cases, the exact period of the migrations and colonizations of various places, extending his researches to the Maories of New Zealand.

The Anthropoid Apes.—A memoir on the anatomy of a new species of chimpanzee has just been published in the Archives du Muséum, by MM. Gratiolet and Edmond Alix. Those who know the scrupulous accuracy and minute descriptive power of the late Professor Gratiolet will appreciate the high value of this work. The specimen was sent over to Paris from the Gaboon, and the authors are inclined to regard it as possibly identical with the tschego mbouvé, or the kooloo kamba of M. Du Chaillu. They, however, complain that the descriptions given by M. Du Chaillu are not sufficient for identification, and hence name the species provisionally, *T. Aubrvi;* seeing that the skull and skins of both M. Du Chaillu's new species are in the British Museum, it is to be regretted that some attempt at comparison is not made. The figures of the skull given by the authors strongly resemble that of the kooloo kamba in its great prognathism and high development of the temporal region of the skull. Should this species be new, we should have the following species of chimpanzee living at the Gaboon:—*T. niger*, *T. kooloo kamba*, *T. tschego mbouvé?* *T. vellerosus*, and *T. Aubrvi*. It really seems desirable that careful comparisons should be instituted between these would-be species. One of the chief points of interest in this work is, that it exhibits the *method* of description which M. Gratiolet considered as the one to be pursued in describing the complete anatomy of any animal. He had intended to illustrate this in a work on the anatomy of the hippopotamus, when he was unhappily cut off in the midst of his labours.

M. de Langle describes, in a letter to the French Academy, the manners of a young gorilla, which was taken from its mother. It clings tightly round the neck of anyone who carries it, and can hardly be forced to let go, this being its natural position with its mother. It eats bread greedily, preferring it to fruit.

Externally and internally Parasitic Acari.—M. Guérin Méneville notes, in a letter to the French Academy, the sudden appearance of innumerable acari — *Tyroglyphus feculæ* — on his potatoes. In less than eight days these little arachnidans became so abundant as entirely to cover the potatoes, and form a seething mass. He is at a loss to account for their remarkable and sudden appearance.

Mr. Charles Robertson, Demonstrator of Anatomy in the University of Oxford, has lately described a form of acarus found inside pigeons, chiefly amongst the connective tissue of the skin, the large veins near the heart, and on the surface of the pericardium. In some respects the acarus described agrees with *Sarcoptes*, but has an extraordinary maggot-like appearance. The discovery of an external parasite inside an animal, in such numbers as Mr. Robertson records, is very remarkable. Colonel Montagu found such acari in the gannet, and Mr. Robertson has since found them in the pelican. It is exceedingly difficult to account for their appearance. Are they undergoing a normal phase of their existence, or have they been accidentally introduced in the cases recorded, and found the habitat a favourable one?

Nerve endings.—The termination of nerves in muscle is a subject which still continues to call forth the energies of microscopic observers. Dr. Moxon has published a paper in the last number of the 'Microscopical Journal,' in which he describes the peripheral termination of a motor nerve of an insect. The case described by Dr. Moxon is one of considerable importance, since the insect-larva (culex) is one which is plentifully distributed, and any competent microscopist can easily find the particular muscle and assure himself of the mode of motor nerve ending. The muscle is the retractor antennæ, and on it the nerve described ends in a corpuscular expansion. This is most clearly figured and described in the paper, and is of course a strong case against the views of Dr. Beale, and in favour of those of Continental observers, unless there be one mode of termination of motor nerves in frogs and another in insect larvæ. Dr. Moxon cannot in any way give his support to Dr. Beale's view, but thinks the question discussed between Rouget and Kühne as to the exact method of termination, after the nerve has penetrated the muscle-fibre, is that to which attention should be given.

PHYSIOLOGY.

Action of Prussic Acid in small quantities.—It is rarely that our brothers in the Colonies contribute anything to the literature of physiology, which is of real value. Mr. Ralph has, however, lately read a paper before the Medical Society of Victoria of great interest, "On the Effects of Prussic Acid on the Animal Economy." He administered prussic acid to various animals, flies, bees, maggots, rabbits, &c., and in all cases found concretions of Prussian blue afterwards in the tissues, having failed to detect any such coloured masses previously. In two cases of persons to whom prussic acid was administered as a medicine the films and concretions of Prussian blue were noticed in the blood with the microscope. From these observations which appear to have been most carefully made, he feels satisfied that prussic acid causes a change in some of the constituents of the blood, that it attacks the iron when in some particular condition, and, with perhaps the aid of some alkaline base, the Prussian blue is formed, which may vary very much, as is well known, in its constitution. He further finds that at the same time as the ferrocyanide is formed, amylaceous particles are set free, and draws some valuable conclusions as to the formation of *corpora amylacea,* and suggests that the iron in the blood may not improbably have other functions besides that connected with oxygen; *viz.* that of being a vehicle or medium for holding carbon and hydrogen together, and for their more ready distribution to the tissues. Dr. Hassall some years since pointed out the formation of *indigo* in the urine and tissues of the body. Mr. Ralph's experiments show that the blue particles are not indigo, but Prussian blue or a cyanide of iron.

The physiological working of Deodorizing agents.—At a recent meeting of the Ashmolean Society of Oxford, Mr. Chapman, of Merton College, described some experiments which he had been performing with regard to the action of various deodorizing agents on the life of ferments. Equal portions of water containing decomposing animal matter were taken, one was left untouched, to a second carbolic acid was added; to a third, sulphate of iron; to another, Condy's fluid, and to a fourth, Burnett's. The development of vegetable life, which is the invariable accompaniment of the destructive fermentation of organic matters, was then looked for daily, in each portion of liquid. In the untouched liquid, abundance of bacteria, and afterwards infusoria, were apparent. In that to which carbolic acid was added the organisms previously occupying the solution were killed, but their lifeless bodies were preserved and remained floating in the liquid. In the case of sulphate of iron there was complete destruction of all trace of organized matter, and a brown sediment of peroxide fell to the bottom of the vessel. Burnett's fluid had an action similar to that of carbolic acid, whilst Condy's fluid was found to act at first similarly to sulphate of iron, but after a short period its virtue was exhausted and a re-development of ferment-causing organisms occurred. The subject is one of great interest, and might be treated in a much more philosophical way than that which Mr. Chapman has adopted. His only object appears to have been to ascertain the practical value of the various deodorants, and he decides in favour of sulphate of iron, as Professor Peltenkoffer and Professor Rolleston had also previously done.

MISCELLANEOUS.

M. de Quatrefages has just published his great work on Annelids, illustrated by one hundred and fifteen figures drawn by himself from life. The plates are good though not truly coloured, and the work is altogether one of very considerable worth. It has not, however, as regards the systematic portion, the conciseness and sufficient detail of such works as Malmgren's and Kinberg's, two Scandinavian naturalists, who exhibit most striking ability in the treatment of the systematic zoology of these invertebrates. M. de Quatrefages has published during the last twenty years many memoirs on families and species of Annelids, detailing new points and discoveries in their anatomy and physiology, and in these volumes the chapter on anatomy and physiology is undoubtedly the best. The author is not a critical naturalist, and hence we could not have expected a more satisfactory result from his labours on the classification and synonymy of the group. This is much to be regretted, since a work which shall tend to set right the species of Annelids is much needed. M. de Quatrefages, we fear, has only added to the difficulty of future writers. His remarks on the nomenclature of parts in the Annelida are very good so far as they go, but there is little attempt at philosophical generalization. At the same time the work is one of very great value and interest, by an author who has done more to elucidate the class than any other living naturalist.

The 'Record of Zoological Literature' for the year 1865 has also appeared: a work of inestimable value to an active naturalist. Dr. E. P. Wright has succeeded Messrs. Greene and Cobbold in their departments of the work, and we are bound to say that the recorders have done their work excellently well, comprising as it does references to, and notices of, no less than 35,000 pages of zoological literature published in the year 1865. This 'Record' is of course one that can only be *read* by Zoologists; but it should also be placed for reference in the library of every man of science. It is one of those works which would never have seen the light were it not for the disinterested love of science manifested by the publisher, Mr. Van Voorst, F.L.S., who, if he fails to derive profit from its publication, is at least entitled to the credit of being one of the most zealous friends of zoological science that we have in Great Britain. The first number of the 'Journal of Anatomy and Physiology' contains chiefly papers read at the British Association and Dr. Humphry's address to his department in full. Besides these, there is a paper by Dr. Lightbody "On the Corneal Tissue"—an Edinburgh prize thesis—which is of considerable value; also a paper by Mr. Wood, of King's College, "On Variations in Human Myology," and numerous abstracts and notices of works and memoirs. We must here state that we are by no means gratified with the plates, which are badly executed, and tend to give a journal, otherwise of very high character, a slovenly appearance.

In addition to the works referred to, we have to notice Dr. Harley's Histological Demonstrations, which are chiefly reprints of lectures delivered by him. The work contains admirable microscopical illustrations of the tissues in health and disease, and will be found of great service to medical students and others who wish to keep pace with the advancing knowledge of the day. Mr. Murray has published a fourth edition of Darwin's 'Origin of Species,' being the eighth thousand.

Quarterly List of Publications received for Review.

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1. Lecture Notes for Chemical Students; embracing Mineral and Organic Chemistry. By Edward Frankland, F.R.S., Hon. Sec. Chem. Socʸ., &c. *Van Voorst.*

2. An Elementary Treatise on Heat. By Balfour Stewart, LL.D., F.R.S., Superintendent of the Kew Observatory. 410 pp. Fcap. 8vo. *Macmillan & Co.*

3. The Student's Text-book of Electricity. By Henry M. Noad, Ph.D., F.R.S. 400 *Engravings.* 520 pp. Crown 8vo. *Lockwood & Co.*

4. The Elements: An Investigation of the Forces which determine the Position and Movements of the Ocean and Atmosphere. By Wm. Leighton Jordan. Vol. I. 120 pp. Roy. 8vo. 13 *Plates.* *Longmans & Co.*

5. Elements of Chemistry: Theoretical and Practical. By Wm. Allen Miller, M.D., LL.D., Professor of Chemistry in King's College, London. Part III. Organic Chemistry. Third edition. 1,040 pp. 8vo. *Longmans & Co.*

6. A Sketch of the Geology of Fife and the Lothians, including detailed Descriptions of Arthur's Seat and Pentland Hills. By Charles Maclaren, F.R.S.E., F.G.S. Second edition, with Maps. 320 pp. Crown 8vo. *Edinburgh: A. & C. Black.*

7. Benedicite: or the Song of the Three Children; being Illustrations of the Power, Wisdom, and Goodness of God, as manifested in His Works. By G. Chaplin Child, M.D. 2 vols. Fcap. 8vo. *John Murray.*

8. Histological Demonstrations: A Guide to the Microscopical Examination of the Animal Tissues in Health and Disease, &c.; being the substance of Lectures delivered by George Harley, M.D., F.R.S., of University College. Edited by G. T. Brown, M.R.C.V.S. Illustrated. *Longmans & Co.*

9. Diarrhœa and Cholera: their Nature, Origin, and Treatment, through the Agency of the Nervous System. By John Chapman, M.D., M.R.C.P. Second edition. 260 pp. Demy 8vo. *Trübner & Co.*

10. An Easy Introduction to the Higher Treatises on Conic Sections. By the Rev. John Hunter, M.A. *Longmans & Co.*

11. A Dictionary, Geographical, Statistical, and Historical, of the various Countries, Places, and principal Natural Objects in the World. By J. R. M'Culloch. New Edition, carefully revised, with the Statistical Information brought up to the latest returns, by Frederick Martin, author of the 'Statesman's Year Book.' Vols. II., III., IV. *Longmans & Co.*

12. On the Origin of Species by means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life. By Charles Darwin, M.A., F.R.S., &c. Fourth edition. *John Murray.*

13. A Dictionary of Science, Literature, and Art. Edited by the late W. T. Brande, D.C.L., F.R.S., and the Rev. G. W. Cox, M.A. *Longmans & Co.*

14. Supplement zur klimatographischen Uebersicht der Erde, mit einem Appendix, enthaltend Untersuchungen über das Wind-System und eine kartliche Darstellung des Systems der Erd-Meteoration von Ad Mühry, M.D. (*illustrated*). *Leipsig and Heidelberg: C. F. Wintersche Verlagshandlung.*

PAMPHLETS, PERIODICALS, PROCEEDINGS OF SOCIETIES, &c.

Researches on Solar Physics. By Warren de la Rue, Esq., Ph.D., F.R.S., Balfour Stewart, Esq., M.A., F.R.S., and Benjamin Loewy, Esq. 2nd Series. *Taylor & Francis.*

On the Absorption and Dialytic Separation of Gases by Colloid Septa. By Thomas Graham, F.R.S., Master of the Mint. *From the Author.*

Observations and Experiments with the Microscope on the Effects of various Chemical Agents on the Blood. By Thomas Shearman Ralph, M.R.C.S. 10 pp. 8vo. *From the Author.*

Report of the Winchester Sewage Enquiry Committee. 45 pp. Demy 8vo.

Our Sewer Rivers. By George Greaves, M.R.C.S. 24 pp. Demy 8vo.

A Description of the New Telescopes with Silvered Glass Specula, and Instructions for Adjusting and Using them. By John Browning, F.R.A.S. 30 pp. Demy 8vo. *From the Author.*

Rhopalocera Africæ Australis; a Catalogue of South African Butterflies: comprising Descriptions of all the known Species. By Roland Trimen, Member of the Entomological Society of London. Part II. Satyridæ, Eurytelidæ, Lycœnidæ, and Hesperidæ. *From the Author.*

On the Results of Spectrum Analysis applied to the Heavenly Bodies. A Discourse delivered at Nottingham before the British Association, August 24, 1866. By William Huggins, F.R.S., F.R.A.S., with an Appendix and Eighteen Photographs. 56 pp. Fcap. 8vo. *W. Ladd.*

A Reply to Mr. Cooke's Pamphlet, "The Electric Telegraph—was it invented by Professor Wheatstone?" *Taylor & Francis.*

Report of a Committee appointed to consider certain Questions relating to the Meteorological Department of the Board of Trade. (From the Committee.) *The Queen's Printers, Eyre & Spottiswoode.*

Further Observations on the Spectra of some of the Nebulæ, with a Mode of Determining the Brightness of those Bodies. By William Huggins, F.R.S. *From the Author.*

A Few Thoughts on Infanticide. By Mrs. M. A. Baines.

Further Observations on the Alleged Submarine Forests on the Shores of Liverpool Bay and the River Mersey. By Joseph Boult, F.R.I.B.A. (For private distribution.) *From the Author.*

The Annual Meeting of the Miners' Association of Cornwall and Devon, held at Falmouth on Monday, 17th September, 1866. 30 pp. Demy 8vo.

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation. *Masson & Fils.*

The Westminster Review.

The Geological Magazine.

Revue des Mines, de la Métallurgie, &c.

Paris and Liege : Noblet & Baudry.

Proceedings of the Royal Society, No. 87.

„ „ Royal Institution of Great Britain.

„ „ Royal Astronomical Society.

„ „ Royal Geographical Society.

„ „ Chemical Society.

„ „ Geological Society.

„ „ Zoological Society.

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THE QUARTERLY

JOURNAL OF SCIENCE.

APRIL, 1867.

I. THE NATURAL HISTORY OF PRATAS ISLAND, IN THE CHINA SEA.

By Dr. Cuthbert Collingwood,* Naturalist on board of H.M.S. 'Serpent.'

Pratas Island is situated in lat. 20° 42′ N., and long. 116° 43′ E., and is of a horse-shoe shape, occupying the centre of the sunken or western part of the great Pratas reef. The reef itself is of a crescentic form, extending 13 miles to the eastward, and having a breadth from north to south of 12 miles, encloses a lagoon of about 10 miles in diameter, dotted over with numberless coral patches and shoals. It lies in the direct line of route between Manilla and Hong Kong, and is therefore a spot where many a good ship has been wrecked, especially upon its south-eastern side, which is too often concealed by the thick fogs which prevail during the N.E. monsoon. The Pratas reef and island were surveyed by H.M.S. 'Saracen,' J. Richards master commanding, in 1858, and at that time it was believed that vessels of 15 feet draught could enter the lagoon by the south channel, between the south side of the island and the south-west horn of the reef, but in our recent visit in H.M.S. 'Serpent,' Commander Bullock found that although only drawing 12½ feet, she could not safely make the attempt, to my great disappointment, and consequently she was anchored on the edge of the reef, 3 miles south of the island, which thus sheltered the ship from the strong N.E. wind blowing at the time.

Pratas Island is about a mile and a half long, and half-a-mile wide, and is only visible at a distance of 8 or 9 miles in clear weather; not rising in its highest part more than 25 or 30 feet above the level of the sea, though the bushes which cover some parts give it an additional elevation of 10 feet or so.

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* It may be interesting to our readers to know that the author of the above article gave up his occupations in Liverpool about a year since, and volunteered as naturalist on board one of H.M.'s surveying ships in the China Seas.

His friends will be glad to hear that in December last he was at Singapore, from which place he sent us the present article, and was about to proceed to Labuan, Sarawak, &c.—The Editors.

On Monday morning, April 30th last, Capt. Bullock and I, with Mr. Sutton, chief engineer of the 'Serpent,' visited the island, two hours' pull from the ship, and I spent the whole day in exploring its character and natural history features. It is formed entirely of coarse coral-sand or débris, generally shelving gradually, but in some parts having a steep bank about 3 feet high. The interior is rough and hilly, from accumulations of similar white sand blown up from the shore, and so overgrown is it with shrubs as to be in some parts almost impenetrable, though the soil might be supposed to be anything but favourable to vegetable growth, nothing but sand being anywhere visible, and that of the coarsest and loosest description. The bushes in some places approach very near the sea, and between them and the water's edge various flowers not unfrequently peep out from the inhospitable soil, including a potentilla, an anemone, a plantago, and some grasses. On the west side of the island is a deep indentation into which the sea enters, forming a shallow lagoon or bay, on the banks of which the vegetation assumes quite a park-like aspect; bushes, and even small trees, with spreading branches springing forth close to the ground, producing a scene of great luxuriance and some beauty. Amongst the bushes immense orthopterous insects (grasshoppers) flew about, exhibiting a deep-red underwing, and looking very much like small birds. To the shrubs also were attached numerous geometric webs, which were occupied by a species of spider belonging to the division *Acrosoma,* having a squarish abdomen, from the upper surface of which projected several spike-like processes. This was the only species of spider which came under my notice; and in its web there appeared to be as often another spider of the same species as any other kind of insect, the paucity of insect life on the island apparently driving them to cannibalism. A moth, whose expanse of wing was about an inch, and having small red and black spots upon the wing, was pretty numerous, and appeared to be the only lepidopterous insect, with the exception of a large clear-winged species, which was captured, but unfortunately escaped again. These, with some ants and a few carrion beetles, constituted the insect fauna, as far as could be determined during our single visit.

Among the coral-débris upon the beach, were numerous masses of various sizes, consisting of rolled Astræas, Madrepores, &c.; and mingled with them were fragments of shells of a great many species of Conus, Cypræa, Turbo, Pinna, Hippopus, &c.; but none of them entire. Innumerable little Hermits (Paguri and Cænobitæ) occupied the deserted shells of Naticæ and Neritinæ, and larger ones those of good-sized Turbines; but I saw no live shells upon the beach, except a few insignificant ones, such as Litorinæ and Purpuræ; nor, though the water was bright and clear, and I waded out as far as I could go, could I anywhere see any traces of Annelids or Echinoderms. The harder parts of the sand were harrowed with deep holes of various sizes, from which emerged from time to time a wary and swift-footed crab (Ocypoda), which scuttled nimbly down to the sea upon the first sign of approaching footsteps, and appeared to be aware of us at least at 50 yards distance. Nor was it easy to capture a specimen, for while on the one hand they never made the mistake of running *away from* the sea, on the other hand, if cut off, they fled so quickly, and *doubled* so nimbly, suddenly running the opposite way without the clumsy process of turning round, that they afforded great amusement and not a little exercise and exertion.

The sea in the neighbourhood of the Pratas Island has a very variegated appearance, from the alternations of bare white sandy bottom, with patches of Ulva and Zostera, both of which are very abundant. The Ulva is a very beautiful reticulated species, and the Zostera leaves float about in all directions and in all stages of decay, generally bearing upon them minute dendritic polyzoa, lunulites, spirorbis, &c., with which the towing-net from the ship was replenished. Besides the Ulva, I obtained several other species of seaweed, washed up on the beach, and conspicuous among them a species of Padina, very abundant everywhere in these seas, and a Sargassum.

As might be expected on so small an island, quadrupeds are scarce, nor did we observe any, though it is said the universal Rat was seen there when the 'Dove' visited the spot, nor did I notice the bones of any quadrupeds which would have indicated their existence there. The skeletons of turtle I met with more than once, but whether they visit the island, or are cast up dead upon the beach, I am unable to say. No other traces of reptiles were observed.

Pratas Island is occasionally visited by Chinese fishermen, who repair to it in the early part of the year, and there is a good junk-anchorage in the N.E. corner of the lagoon. We soon came upon traces of such a visit in a clear patch among the scrub, in the midst of which a well had been sunk, from which brackish water might be obtained. There were scattered about various implements of pottery, in the shape of water-vessels and teapots, some entire and others more or less broken, and surrounding them were strewed great numbers of shells, of a species of Strombus, the remnants of a past feast, and which remained to form a future kitchen-midden in the sand. At the head of the shallow inlet or lagoon stood a joss-house, or Chinese temple, in a rather dilapidated condition from the effects of wind and weather, the roof nearly torn off, and the plank walls very shaky, so that the rain and weather had left their visible traces also upon the contents and furniture. In this rough building were 30 or 40 josses, or wooden idols, of various sizes, once resplendent in paint and gilding, but now faded and weather-worn. They were arranged symmetrically upon a sort of altar, and upon the tables before them were bundles of joss-sticks, packets of joss-papers, rouleaux of paper dollars, lucky stones, gongs, tom-toms, while around the building were grotesque wood carvings, procession staves, and all the paraphernalia of the Chinese devil-propitiators. We soon found, however, that they must be handled with caution—they were rotting with damp and decay, and harboured numbers of small scorpions, white ants, and ugly-looking spiders, which commanded a certain amount of respect from their malignant and venomous appearance. The blue-jackets especially, with their bare feet, were very shy of walking about in a spot where scorpions had their habitation, but fortunately no one suffered from their stings. Among other offerings to Joss, were a number of large model-ships, representing three-deckers, and made of paper stretched upon frames of wood, now much torn and dilapidated, but which showed plainly the piratical tendencies of the frequenters of the temple, and their desire that Joss should cast some barbarian ships upon the shore for them to plunder. As far as we could judge, however, from the condition of the place, it must have been three or four months since anyone had visited the island.

A slope of long, rank grass led down from the joss-house to the shores of the shallow inlet, upon which, and in the water, were strewed immense numbers of dead shells of Cerithium, some few of which were inhabited by hermit crabs. From observations made at the island upon the tide, it appeared that during the day of full moon it was high water at 8 a.m., and ebbed until 3.15 p.m., by which time it had fallen 3 feet. It was not surprising, therefore, that some of these deserted shells were high and dry, but this would hardly account for the fact that, considerably above high-water mark, many lay half-embedded in the dried mud and thick confirmed growth which had long lain above high-water mark, and bore the signs of having been well baked and cracked by many a noonday sun. The banks of the lagoon had evidently been under water comparatively recently, and much higher up than the tide now reached.

But although some classes of animals were poorly represented upon Pratas Island, there were plenty of birds, and of several species, both sea and land birds. A buzzard I noticed several times, but it was too wary to allow me to come within gunshot, although it offered a tantalizing mark just out of range. I observed a very handsome shrike, with an ash-coloured head and black moustache. The blue-jackets reported that they had seen a canary, and I afterwards saw myself a yellowish bird resembling the English Siskin, which was probably the bird they had noticed. Another bird, about the size of a blackbird, was of a glossy metallic blue above and fawn-coloured beneath. Its stomach contained the elytra of beetles. A fifth species presented all the appearance of a veritable blackbird, but I could not get near enough to examine it closely. A species of swallow, with glossy bluish back, chestnut neck, and with a speckled fawn-colour underneath, was flying about in considerable numbers; and on the banks of the shallow inlet I saw a bright-coloured kingfisher, very similar in appearance and size to our own species. There were also some small birds which crossed our path from time to time, with the jerking flight and the chirrup of the hard-billed passeres. Large flocks of Tringas (sandpipers), of at least two species, were visible on the sandy flats of the inlet which were left uncovered in the afternoon, and also upon some parts of the seaward shore of the island, where it was inclined to be soft and marshy. There were also two species of plover, the one of a reddish-brown colour, with orange-red legs; the other of a delicate mouse colour, with yellow legs; and a godwit (Limosa), speckled grey and brown, with greenish legs and a recurved beak. A large rapacious-looking bird, which came sailing majestically within gunshot, was brought down, and turned out to be the frigate bird (Tachypetes aquilus), a bird confined to tropical regions, but having a wide range throughout them, being not uncommon both in the Atlantic and Pacific Oceans. When it fell, a strong guano-like smell pervaded it, which was very disagreeable. I measured its expanse of wing, which proved to be nearly 7 feet from tip to tip; and on opening its stomach I found, in a partially digested state, three large flying fishes and two squids. Small flocks of a pretty species of white egret frequently flew along the shore, and indeed, with gannets, made their appearance about the ship immediately upon her anchoring off the shoal. I shot one from the ship for examination, and found it to be 20 inches long from tip of beak to end of tail, and of a pure white colour, with the exception of a few orange feathers over the base of the beak, which formed a sort of crest, bill yellow, and legs greenish brown. It was not provided with any of those special feathers which adorn our British species. The stomach contained a few remains of beetles.

But the dominant and characteristic bird of Pratas Island is the gannet. These birds measure 4 ft. 10 in. from tip to tip of wing, and 2 ft. 9 in. total length from beak to tail, which is wedge-shaped. The head, neck, back, and tail are fuscous, breast and belly white, legs and feet yellow, and completely webbed. They are common birds on most of these islands, and are well-known to seamen. They fly heavily and usually low, fearlessly approaching within gunshot, and even stone's throw, and some of the men amused themselves with throwing lumps of coral at them as they flew by, the same bird returning again and again at the risk of being knocked down.

A walk through the interior of the island among the shrubs and bushes revealed to me the domestic economy of these birds. In the open places, and under the shelter of the bushes, the mother gannets were sitting upon their nests and eggs. The nests were mere hollows in the coral sand, strewed with a few bits of grass, with some admixture of feathers, and perhaps a bit of seaweed, forming, at best, a very rude cradle, in which were deposited two eggs. These eggs were about the size of goose eggs, white, with a suspicion of a blue tinge, not smooth and glossy like hens' eggs, but more or less scratched, as though the scratches were made when the external coat was soft, and had afterwards dried preserving the marks. One nest only contained four eggs. The poor bird sitting upon this nest would show symptoms of uneasiness as I approached, pecking the ground or coarse grass fiercely with its long, straight beak, but did not offer to quit the nest until I was within two or three yards of it, or even less. Then placing the end of its bill upon the ground, with a gulping effort it vomited up its meal, depositing it beside the nest, and floundering forward, took wing and rose into the air. This was the proceeding at nearly every one of the hundreds of nests which I disturbed; it was evident that the birds had just gorged themselves with food, and then sat down upon their eggs (unless, indeed, the mate had brought them food, a circumstance which I did not see myself), and that they were unable to raise themselves off the ground until they had got rid of the superfluous weight in their stomachs. On examining the vomited food, I found it to consist invariably of flying-fish, generally of a large size, and usually but slightly digested. There were sometimes six or seven of these fish, in other instances only three or four, and in two or three cases a squid or two intermixed with them. But what numbers of flying-fish must exist in the neighbourhood to afford such a daily supply to so large a number of birds! and yet we did not see a trace of flying-fishes about the island, and might otherwise have supposed there were none. Meanwhile the gannets formed a thick cloud overhead, the noise of whose screams and the rustling of whose wings formed a wild accompaniment of sounds. They flew so close overhead that I could have knocked them down with a stick in any numbers, and was obliged to wave my gun about as I walked along, in order to keep them from carrying away my hat. By degrees the birds rose higher, and those I had disturbed returned to their nests as soon as I had passed a few yards.

In the latter part of the afternoon a seining party came from the ship, and the nets being prepared, four casts were made very successfully. A great number of fish were taken and stowed away in the sail-bags, but it was too late and too dark to examine them very closely, and they were distributed amongst the ship's company and dressed for breakfast. Among them were a great many of a large silvery mullet; no flying-fish, however. In one of these hauls the net was so impeded by the quantity of the reticulated Ulva before mentioned, that it was drawn in with great difficulty.

It was now dark, and a breeze was springing up. A blue light burnt from the shore was answered by another from the ship, thus distinguishing her position, and Capt. Bullock and I embarking in the gig were soon scudding along under sail. Meantime the full moon rose grandly over the sea, and in half-an-hour we had measured the way back to the ship which it had taken two hours' hard pull to do in the morning.

The towing-net hanging out from the ship when lying off the island was, the first evening, filled with a dense brown deposit, which on examination proved to be composed solely of Zoëæ, all of the same species. The next morning on raising it again in the same spot, not a Zoëa made its appearance, but instead of them were numbers of Leucifer, Entomostraca, and other minute Crustacea, also little Atlantæ; fronds of reticulated Ulva, and decaying leaves of Zostera, upon which were Lunulites, Spirorbis, and minute Polyzoa.

A strong N.E. wind prevented us the following day from paying another visit to the island; while, lying under its lee, we remained at anchor for the sake of the shelter it afforded us. But on the second day, towards sunset, our attention was attracted by the curious phenomenon of long rolling waves coming in from the south-west, which increased as the evening advanced, causing considerable motion in the ship. Towards midnight these S.W. rollers increased to such an extent, the wind still blowing strong from the N.E., that Captain Bullock deemed it desirable to slip cable and put to sea, since the proximity of the reef was very undesirable if bad weather set in, while the rolling swell endangered our bumping upon the reef in a spot where our fair-weather anchorage left but little room to spare. We kept outside the edge of the reef therefore during the night, and next day approached its N.W. corner. Here we saw the terrible sight of the long line of breakers on our lee side, extending for miles along the northern edge of the reef, over which the sea, lashed into foam by a strong breeze of some days' duration, was dashing wildly in a broad straight band of white foam. Finding that the wind freshened and that we could do no more at the Pratas Shoal, we steered N.E. and left the dangerous reef behind.

The explanation of the curious phenomenon of S.W. rollers coming in with a N.E. wind followed in due time. They were caused by a typhoon which was blowing between 200 and 300 miles to the south of us, and which *recurved* in lat. 16° 10′ N. and long. 116° 30′ E., according to the observations of Capt. Symington, whose ship, the 'Northfleet,' was twice caught in it, and who published an account of the Cyclone.

Pratas Island being so small a spot and situated 170 miles from the mainland of China and about 250 from Formosa, it is remarkable that so many land-birds should have found a home there; and the incidents of the two or three days which elapsed during our passage from the reef to the Island of Formosa were particularly interesting, as throwing light upon this circumstance. Steering N.E. for Tacao-con, we experienced a strong head-wind the whole way, that is, the direction of the wind being in a straight line from southern Formosa to Pratas Island. We left the reef on May 3rd, on the 4th a large flock of sandpipers met us going with the wind towards Pratas, where no doubt they would find a resting-place. But the following day, being then a little more than halfway from the reef to Formosa, the rigging was scarcely free at any time during the day from feathered guests, which must have been driven off the Formosa coast by the wind, and some of them at least would have reached Pratas had they not found a resting-place and in some instances a passage back, on board the 'Serpent.' The following birds I observed at various times during the day, and sometimes several of them flying about the ship, and from time to time lying on various parts of the rigging; a yellow warbler (Sylvia), a yellow wagtail (Motacilla), a shrike (Lanius), grey with a black moustache, apparently identical with the one already seen on the island, two species of swallow (Hirundo), a small heron (Ardea), a very handsome blackbird rather bigger than a common blackbird, with a crimson beak and a large white spot on each wing, a very pretty red dove with a white head, a yellow and black spotted plover, precisely resembling the British golden plover, a species of flycatcher (? Myiagra azurea), and a bird closely resembling a hen chaffinch (? Munia topila).

This interesting assemblage of birds was evidently but a few of the numbers blown off the land (probably Formosa) by the force of a moderately strong N.E. wind, and of them, many would perish in the sea, a few would find relief and restoration in passing ships, and without doubt some would reach Pratas Island, and finding means of subsistence, would take up their residence there, and be jotted down in the Avi-fauna of the next observer.

II. NERVE STRUCTURE AND FORCE.

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A superficial examination of the earth's crust shows, that from the most remote epochs there has been a succession of animal forms corresponding with the nature of the atmosphere in which such animals were framed to live; also that the transition from sea to estuary, and from estuary to river and thence to dry land, has been slow and without violence; and that among the marine strata there are mingled both animal and vegetable productions belonging to fresh-water life or the inhabitants of dry land. The study of geology therefore embraces not only the structure of the earth, but likewise natural history, comparative anatomy, and the physical sciences generally, and hence proves to its followers a source of endless intellectual enjoyment.

Among the early ideas, which strike us, is the important part played by the invertebrate or lower forms of animals, as compared with the vertebrate, in the history of the revolutions of the globe: through their ceaseless operations, islands are raised in the middle of the ocean, while from their débris such masses as those which constitute our chalk-cliffs are constructed. Whatever may have been the decree of the divine will as to their first creation, they must each in their generations have increased and multiplied until their missions were respectively accomplished. Some inquiry into their nature and organization becomes therefore interesting.

There are two great functions in operation in all forms of animal life, without which the race becomes extinct, namely, alimentation and reproduction. Even in the most complex organisms, such as man, endowed with the highest faculties and capable of the grandest mental efforts, the desire to "eat to live" and the fostering love of offspring constitute the most abiding emotions. In savage life the hunter will endure any amount of fatigue to secure his supply of food, and will fight to the death for the preservation of his young; and so among brute animals, though in a less degree, until, in the more simply organized, the love of self consumes all other feelings under the form of a reflex action of personal wants, and the young are provided for by those mysterious laws whose phenomena we may study, whose source and directing power we can refer only to the "One great Cause."

In the vertebrata, the organs of alimentation consist of a tube with oral and anal aperture; of teeth, to seize and grind; and of numerous accessory glands, such as parotid gland, liver, pancreas, &c. By means of these the nutritive material is prepared, that it may be subjected to other changes, which convert it into blood;

and then come excretory organs, such as the kidneys, to deprive the blood of all noxious principles. But in the invertebrata, the mode of alimentation is often more simple, although we may find the animal supplied with other organs fitted for its own preservation, but not directly for propagation, such as poison-bags, spinning apparatus of spiders, the ink-bag of the cephalopods.

Under most conditions in the animal world the act of reproduction takes place by means of an ovum or egg, which is fecundated by the spermatozoon, a mysterious germ moving about in a peculiar secretion. The organs, therefore, subservient to such functions are the most important. But other modes consist in the act of spontaneous fission or division of the parent animal, or by the act of budding or gemmation.

The young animal which leaves the egg is very often an exact counterpart of the parent, differing only in size, as in the case of the common chick; but in a vast number of instances this resemblance does not exist; sometimes the young require yet further evolution and change; in other cases there is no resemblance at all, either in form or mode of living; and this brood may repeat itself in its dissimilar character, or may again acquire the peculiar organs which bring it back to the parent shape. Then again we have the well-known metamorphoses as illustrated by the larvæ of insects, in which the offspring, though unlike the mother, passes through a definite series of changes, until it again acquires the parent form, again to reproduce in like fashion, and finally to die.

In all animals this function seems under the direction of what, for want of a better term, has been called "vital principle," "nerve power," &c.—not that brain ganglia or nerve fibres can invariably be found—but the changes are such as can hardly be explained on the ground of mere chemical affinity or of nutrition and assimilation.

What have we to say of nerve-power? Viewing it from its lowest manifestation, we may regard it as some dynamic force, evolved and regulated by co-existing, but yet unknown laws. Regarded from its higher attributes, we must incline to a principle of life, which is something superadded to ordinary laws, something which, while it lasts, keeps in abeyance the usual elements of deterioration and decay. Call it what we will, the ψυχη; the vital principle; its presence expresses life and creative or constructive action; its absence, decay, dissolution, degradation.

In the lowest forms of animal life, its presence is recognized by no known structure, but we soon observe nerve ganglia and fibres. They first appear about the oral aperture, their fibres extend to the radiating tentacles. The distribution of such nerve fibres and ganglia depends on the form of the individual, so that in myriapoda and annelida, they are repeated at segmental intervals, or concentrated in insecta, where the vitality is most clearly manifested in the head.

But as the higher manifestations of the mind become developed, so we notice that the accumulation of nerve-matter about the head increases; and that moreover there is a distinct line of demarcation between one kind of nerve substance, which is white, and another, which is grey; in other words, between the "nerve generators," or holders, and the "nerve conductors."

In the present communication my object will be to trace the relation between the habits of the animal and the functions performed by its different organs, with the apparent object of its mission. Such an inquiry, embracing the most comprehensive field of natural history, appears to me to exceed, in our day, the capabilities of a single individual; and my remarks must therefore be received only as a partial contribution towards our knowledge on the subject.

In both water and air, the two atmospheres which support animal and vegetable life, nature has provided means for maintaining purity and freshness. The antagonistic influences of animal and vegetable respiration have long been recognized, and similar provisions are made for fresh and salt water. The great sources of impurity in the two latter would proceed from the surface and from the deep, and not from the intermediate strata. On the former, and especially in warm climates, we should find hosts of insect forms; in the latter, multitudes of infusoria, small crustacea, and other denizens of the water.

It is said that if the young gnat were not devoured by fish, water-fowl, &c., the air would become darkened, even in this cold climate, by their immense multitudes. The same remark applies with greater force to the mosquito, each female of which lays annually, on the surface of water, about 300,000 ova. But there are yet other forms, more minute and microscopic, which in summer time may be detected in the spray thrown up by the paddle of the steamboat. What means are provided for keeping within bounds this exuberance of life?

Among the most beautiful appearances presented by the ocean is the silvery phosphorescent light, seen on a summer's night, illuminating the track of every boat and defining the contour of the waves. This subject has been studied by many naturalists, the foremost of whom is M. de Quatrefages, of Paris, whose researches on *Noctiluca miliaris* are too well known to require comment; and an important addition to our knowledge has also emanated from the labours of Professor Huxley. This luminosity proceeds in the main from living invertebrate animals—*Protozoa*, *Medusæ*, annelids, crustaceans. Among these the most important part is played by a singular and anomalous creature, of very simple organization, the *Noctiluca miliaris* just named. This form has been described as a gelatinous transparent body, about $\frac{1}{60}$ of an inch in diameter, having very nearly the form of a peach; where the stalk of the peach might be, a filiform tentacle, equal in length to about the diameter of the body, depends from it, and exhibits slow wavy motions when the creature is in full activity. The body is composed of a structureless membrane; beneath this there is a layer of granules, or rather, a gelatinous membrane, through whose substance minute granules are scattered without any definite arrangement. From hence arises a network of very delicate fibres. There is an oral aperture, a sort of half oval, with a straight edge anteriorly, and a deeply curved outline posteriorly. From the bottom of the oral cavity a very delicate filament is occasionally protruded, which exhibits a rapid undulating motion, and is then suddenly withdrawn; doubtless, as suggested by Krohn, who first discovered it, the function is to sweep nutritive matter into the oral cavity. Close to the right extremity of the anterior oral margin, is a horny-looking S-shaped ridge, named by Huxley, a tooth, 1-7000 inch high. The oral aperture leads to the granular mass of the alimentary cavity, from which the fibres and the fibrils radiate.

What purpose now does the luminosity of *Noctiluca* serve? Passing down the Mediterranean in 1854 I was struck with its brightness and universality on most nights. Is it a voluntary act on the part of the animal, or is it determined only by reflex laws? In the fire-fly (*Lampyris Noctiluca*) it serves for the attraction of the sexes, and can be extinguished and renewed as the animal pleases. In *Noctiluca miliaris,* its purpose must be for the attraction of its minute prey: the oral aperture, its tongue and teeth all point to the fact that the animal is carnivorous, and serves to keep down those still more minute animal forms, which might otherwise render the water in which they live and generate, impure. But no distinct nervous system has here been traced.

Another class of marine animals, also carnivorous, the *Actiniæ,* live among rocks and broken surfaces, where they perform a similar purifying function, by the destruction of animals of larger form and of apparently much greater power than they themselves possess. But in these, as in the preceding, no trace of nerve matter can be clearly found, and yet they exhibit a power of selection which gives evidence of sense. If a young actinia be put within the tentacles of a larger individual, that fatal grasp is withheld, while a young crab or prawn is promptly seized and devoured. Its migrations, though slow, have usually some definite purpose; it avoids bright light, preferring the shelter of a piece of rock; it requires air, and will hang, tentacles downward, for hours from the surface of the water, floating by means of an air-bladder of its own formation.

Near the oral aperture we often see a series of bright spots, called Ocelli; they are not always present, and are subject to change of colour—are brighter at some times than at others. They have been considered by some as organs of vision placed on nerve ganglia, but of this we have no anatomical nor optical proof; moreover, of what use would sight be to an animal so incapable of pursuit and unfit to avoid danger? They can serve no sexual purpose, for male and female organs are combined in the same animal. They may by their brightness attract other occupants of the ocean which are suitable for food, or they may be some of the earliest traces of nerve structure, acted on by light, and serving to direct the movements towards those regions where life may be best maintained.

Siebold expresses the opinion of most observers in saying that as yet only a very rudimentary and imperfectly-distinguished nervous system has been made out in the polyp; this consists of round masses, which are regarded as composed of nervous matter (ganglia) situated in the parenchyma. A ganglion of this kind has been supposed to have been observed about the mouth. Investigations upon their organs of sense have not been more successful. However, the sense of touch appears developed over the whole surface of the body, but especially so in the extremely irritable arms and tentacles; but, as yet, no tactile nerves have been found in these parts. In the same manner, light, to which these animals show a greater or less sensibility, is perceived rather by the general surface of the body than by special organs. There are, however, in some species, at particular stages of development during which they swim freely about, certain nicely-defined structures situated upon the sides of the body, and which may be regarded as special organs of light and sound. This is the case with *Syncoryne;* and *Coryne* has in their place four red organs, which correspond exactly to those found on the border of the disc of the pulmograde *Acalephæ*, and which have been regarded as organs of sense. The organ seen at the base of the six arms of *Eleutheria dichotoma* has quite the appearance of an eye; that is, there can be distinguished in it a cornea, a crystalline lens, and a red pigment layer surrounding the whole.

The Rev. W. Bingley, the author of an old but well-known work on Animal Biography, gives the following quaint but truthful account of the earth-worm, or as he calls it, the dew-worm (*Lumbricus terrestris*):—"The most insignificant insects and reptiles are of much more consequence, and have much more influence in the economy of nature, than the incurious are aware of; and are mighty in their effect from their minuteness (which renders them less an object of attention) and from their numbers and fecundity. Dew-worms, though in appearance a small and despicable link in the chain of nature, yet if lost, might make a lamentable chasm; for, to say nothing of half the birds and some quadrupeds which are almost entirely supported by them, worms seem to be the great promoters of vegetation (which would proceed but ill without them) by boring, perforating, and loosening the soil, and rendering it pervious to rains and the fibres of plants, by drawing straws and stalks and leaves and twigs into it, and, most of all, by throwing up such infinite numbers of lumps, called worm-casts, which form a fine manure for grain and grass. Worms probably provide new soil for hills and slopes, where the rain washes the earth away, and they affect slopes, probably to avoid being flooded. Lands that are subject to frequent inundations are always poor; one great reason of this may probably be, because all the worms are drowned."*

Let us examine the worm more closely. Its colour is no matter of chance: the dark brownish-black hue, resembling the colour of the soil in which it lives, gives the best chance of escape from the keen-sighted birds which make it their prey: and of a similar provision we have numberless examples in both invertebrate and vertebrate divisions of the animal kingdom; in the former, for example, the green colour of the grasshopper, the brown hue of the cigale, whose abode is the dried branches of trees. Even the converse may be noted, namely, that colours may be made subservient to predatory habits, as we witness in the sandy-coloured lion, the inhabitant of a dried and parched soil; the striped and brilliant-hued tiger, which lives among the long grass of the jungle; or the panther, whose spotted hide may be mistaken for part of the leafy foliage among which it lies crouched.

The firm thick dermal covering and the muscularity of the earthworm are just such as would enable it to burrow in the moist soil: its thickness is great, and by reducing the size of the abdominal cavity serves to protect the viscera. The nervous system consists of a supra-œsophageal ganglion, united by two fine chords, surrounding the gullet with the sub-œsophageal ganglion, and thence proceeds a nervous chord along the abdominal aspect of the animal. There are no eyes, for sight is not wanted, but nerve-filaments go to the oral aperture, and to the appendages which proceed from it.

A circulatory system, consisting of a dorsal and ventral vessel, with transverse side branches, but with no very definite current of blood, is best adapted for the habits of an animal subject to sudden and unequal pressure, while the respiratory apparatus is an aqueous sac, lined with vibratile cilia within the abdominal cavity, on either side of the body.

The mode of reproduction is by a distinct sexual apparatus, which comes to maturity at fixed times of the year. In every animal there are both male and female organs, although the congress of the sexes seems necessary to impregnation.

It should be noticed that in the Annelids we first observe a trace of a "sympathetic nervous system," of which more will be said when speaking of more highly organized animals.

The acephalous mollusca are characterized by having a headless body, and a very large mantle, which so envelopes the body that there is a spacious cavity in which both oral and anal orifices are entirely concealed. Most are supplied with a calcareous covering termed the shell. The nervous system consists of a number of scattered ganglia, united by filaments with the œsophageal ganglia; there is a distinct circulatory apparatus; air-cells or branchiæ for respiration, and in many instances organs of vision. The mode of life of these animals, and the offices which they perform in nature, may be studied by the habits of the *Solen;* and the nature of the gasteropoda by the structure of the *Paludina*, or the *Buccinum.*

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* P. 500.

The oblong form of the bivalve razor-shell is well known; also the structure of its foot, which enables it, by change of form into a hook or a form of globular anchor, to sink or to rise in the soft sand. The *Solen* is essentially a sand-borer, penetrating to a depth of a foot and a half to two feet, rising for its food, and burrowing out of danger, and mostly maintaining its vertical position until death overtakes it, when its calcareous covering remains. The light sandy colour of the shell resembles the soil in which it lives; its cutting shape best enables it to divide the soft sand; its scattered ganglia diffuse sensation over the several parts of an animal requiring no active influence of centralized nerve force, but rather a lower power generally diffused over its irregular shape.

The scattered ganglia of the nervous system of the invertebrata, and the absence of a well-defined brain, constitute an arrangement by which the organic functions of the body may be best sustained, without the exposure of the animal to the perceptions of pain. The movements excited in its search after food must, in all probability, be reflex, and due in great part to the physical action of the rays of light; or currents caused by ciliary movements, bringing objects within its reach, which, when touched, are seized, swallowed, and digested. The act of deglutition brings the food within the influence of the secretion of a liver; but no regular periods of hunger prevail, and the animal can live long without taking food at all.

But ample provision is made for increase and procreation, and in many instances by more than one process in the same individual. The external senses consist chiefly of sight and touch, but the power is very feebly developed, so long as animals are fixed to rocks and other objects; on the other hand, in the invertebrata of flight, such as *Insecta*, the eyes are large and compound. Thus it is arranged that the rate of increase in regard to these animals is not under the disturbing influence of accident or passion; that the supply is constant and equal to the requirements of the earth, while the important changes which are effected by their death in countless myriads, either as framers of rocks, or as a supply of food to larger and more vigorous creatures, takes place without pain or suffering, or those disturbing emotions of the mind, implanted with more or less intensity in all the vertebrate sub-kingdom.

The predacious habits of the Cephalopods, involving definite and rapidly executed powers of locomotion and prehension, with sight, hearing, and the exercise of choice, imply the necessity of a very different kind of nervous system. The central mass, it is true, forms an œsophageal ring, which consists of a superior and an inferior ganglionic mass, connected by lateral commissures. The superior is small, and sends some delicate nerves to the parts of the mouth. But the inferior portion is very large, and extends along the sides of the œsophagus in order to be directly connected with the broad commissures. An olfactory and two optic nerves arise from the lateral portion of this ganglion, while the auditory nerves have their origin from its inferior surface. From its anterior border pass off four or five pairs of large nerves to the arms, and also others to the muscles of the head. From its posterior border arise small nerves for the funnel, and also two large trunks for the back of the mantle.

The eye is composed of numerous membranes and is covered by the skin, which becomes transparent in passing over it, and sometimes forms folds that supply the want of eyelids. The ear is merely a little cavity excavated on each side near the brain, without semicircular canals or external passages, and in which there is suspended a membranous sac containing an otolite. The fleshy point of the tongue is undoubtedly a gustatory organ. There are olfactory organs situated in the neighbourhood of the eyes. The organ most highly developed is the organ of sight.

In the cephalopods we find well-marked "pneumogastric nerves." They arise from the middle of the inferior cerebral mass between the two pallial nerves, or nerves of the mouth; they descend along the neck behind the funnel, the posterior wall of which they pierce, and thence pass under the peritoneum, sending several nerves to the ink-sac and ramifying upon the heart; the large vascular trunks, the branchial hearts, and the branchiæ. There is moreover a distinct splanchnic nervous system.

A nervous system thus highly developed implies the active exercise of the organs with which it is supplied. The parrot-beaked mouth, the prehensile suckers, are structures which even the larger vertebrata would shrink from encountering. We read of the "*Sepia octopodia*," of the early naturalists, attaining in hot climates such a size as to measure twelve feet across its centre, and to have each of its arms between forty and fifty feet long! "When the Indians go out in their canoes," says Bingley, "in places frequented by these sepia, they are always in dread of their flinging their arms over and sinking them; on which account they are careful to take with them an axe to cut them off."* Without

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* 'Nat. Biography,' p. 519.

First Appearance of Man.—From Figuier's 'World Before the Deluge.'

acknowledging such tremendous powers, we may mention that sailors who have irritated cephalopods with their boathooks, have had their naked arms, immersed in the water, suddenly seized by the suckers, while the animal in its fury has endeavoured to plunge its beak-like mouth into the flesh.

But these more highly organized and more locomotive animals do not appear to leave such lasting memorials of their presence as those of simple construction. Their mission is essentially destructive. They keep down redundancy of life, but we do not find that they raise atolls like the corals.

We must, however, qualify this statement by limiting it to comparatively modern times, for as the late Dr. Mantell remarked, "The living species are but representatives of the countless myriads which swarmed in the ancient seas."* Their fossil remains comprehend the most varied and striking forms of extinct beings that occur in the sedimentary strata, from the earliest secondary to the latest tertiary formations. Their fossil remains consist of the external shells, the osselet, or the internal calcareous support, the ink-bladder, with its inspissated contents or sepia; the mandibles, and some of the soft parts in a state of "molluskite."

This imperfect sketch of the nervous system of the invertebrates, and its relation to the functions which it performs, must serve as an introduction to the study of those higher types to which I hope at no distant period to direct attention. In these the relations of structure and function will be more clearly appreciable, and the connection between both and the objects of animal existence will be made manifest.

†III. THE POLYNESIANS AND THEIR MIGRATIONS.

By Alfred R. Wallace, F.R.G.S., &c.

The origin of the various races of the islands of the Pacific has always been one of the most difficult problems for the believers in the unity and the recent origin of man. Their diversity of physical features, of civilization, and of language, the absence of any continental races to which they could be affiliated, and the wide spaces of ocean over which they are distributed, have hitherto seemed to indicate that their origin dates from a period so remote that we cannot hope to determine it with any approach to certainty.

M. Quatrefages, however, an eminent anthropologist, has courageously attempted to solve the enigma of the origin of the Polynesians, the most important of the Pacific races. He very properly limits this term to the brown races spread over a wide area from the Sandwich Islands in the north to New Zealand on the south, and from Easter Island on the east to the Tonga and Samoan groups on the west, but all speaking dialects of one well-marked language. Now what M. Quatrefages attempts to prove is, that these people are simply Malays, who migrated from some islands of the Malayan Archipelago (probably Bouru in the Moluccas), and have more or less intermingled with the races of Melanesia and Micronesia. His evidence to prove this is of two kinds:—first, he endeavours to show that a migration has taken place; secondly, that the Polynesians are in their physical, mental, and moral characteristics, a true Malayan race.

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* 'Medals of Creation,' p. 448.

† 'Les Polynésiens et leurs Migrations,' par M. de Quatrefages, Membre de l'Institut, Professeur au Muséum. Paris, pp. 199. Arthur Bertrand, Editeur, 21, Rue Hautefeuille.

1. *Migrations.*—We find in M. Quatrefages' volume a very careful summary of all the native accounts of their migrations, and also of the involuntary migrations that have recently occurred. These, no doubt, prove that the Sandwich Islands and New Zealand have been peopled by emigrants from the Marquesas and Tahiti, and the fact of this emigration is confirmed by the independent evidence of language. It is proved, therefore, that the Polynesians have passed over immense spaces of ocean, in directions not especially favoured by winds or currents, and thus the difficulty of any migration, merely from its distance, is quite overcome. It is further shown that all the traditions point to the Samoan group and the Fiji Islands as the central points to which almost all Polynesians trace their origin. It is to be observed here that these are the largest of all the islands in the central Pacific inhabited by the Polynesian race, and it is these, therefore, that we should naturally expect to have sent out colonies to the smaller islands. So far we have the strongest corroboration of there having actually been a migration in the fact of the community of language, and all the legends of these migrations speak of them as having been made by simple men, the natural ancestors of the existing Polynesians. But in the legend which refers the origin of the Samoans themselves to a migration from a large country "further west," we get into pure legend,—for the mythic Boulotou, whence the first inhabitants are said to have come, is a spiritual and not a real country, and these inhabitants are believed to have been not men, but inferior gods. And even the direct evidence of migration having been generally from the west, is by no means so clear as M. Quatrefages appears to believe; for one of the latest authorities on the subject, Mr. W. T. Pritchard, who has spent his whole life in the Pacific, and who from his long residence in the Fiji and Samoan Islands as British Consul, and his intimate knowledge of the Polynesian languages, is well qualified to give an opinion on this matter, says it is just the contrary. In his 'Polynesian Reminiscences,' p. 402, he observes: "It is, however, remarkable that in all these many instances of authenticated driftings, the course of the

drifted canoes has been *from east to west*, before the prevailing trade winds, and *not from west to east* before the westerly winds;" during the prevalence of which he tells us the natives do not usually venture out on fishing or travelling expeditions. In this case, too, the corroborative proof by language completely fails, for though there is an undoubted Malay element in the Polynesian language, it is an element derived from the civilized Malay and Javanese tongues, not from those of the Moluccas, which are totally distinct.

It is to be noted also that this Malay element in the language has all the character of a recent introduction, since the Malay words are hardly changed, except by the phonetic character of the language which has received them.

2. *Physical Characters.*—The Malayan origin of the Polynesians at a comparatively recent date implies much physical similarity; for even if the Malay formed a still larger portion of the Polynesian language than it does, this would not prove a community of race, unless the physical characters also in some degree corresponded. It is here that we find an absolute defect of all evidence bearing upon the point in question—the similarity of the Polynesians to any race speaking the Malay language. Almost the only evidence adduced by M. Quatrefages goes to show the similarity of the brown race of Timor to those of Polynesia. But the Timorese are not Malays at all; they belong to that curious race which has close affinities to the Papuan in all moral and physical characteristics except colour, and their languages are much further removed from the Malay than even the Polynesian itself. The resemblance physically of this race with the Polynesian proves absolutely nothing with regard to the Malay question.

Now let us compare the most important and thoroughly well-established physical and mental characteristics of the two races:—

Polynesians.	*Malays.*
Tall, averaging—	Short—
5 ft. 10 in. . . Wilkes (Samoans).	5 ft. 4 in. or 5 ft. 6 in.
6 ft. . . Dupurey (Tahiti).	
Hair wavy, curly, or frizzly.	Hair always straight.
Beard often full.	Beard scanty or none.
Face handsome, European type.	Face never of European type.
Nose often aquiline.	Nose never aquiline.
Disposition active and joyous.	Disposition slow and morose.
Character open and frank.	Character eminently secretive.
Often erected stone edifices.	Never used stone for building.
Use double canoes.	Use single canoes.

In the following passages from Consul Hopkins' recent work on Hawai, the italicized passages show points in which the Polynesian is the exact opposite of the Malay:—

"The hair of the Hawaians is black or *brown*, strong, and frequently *curly*."

"The Hawaians are strong, well-made, and active, in height rather *above the average of Englishmen*. . . The Hawaians possess the virtue of *courage in an unquestionably high degree*. . . . They are now as peaceful a people as any upon earth; they are more *free from crimes of violence* than any nation that can be named. . . The natural disposition of the Hawaians is everything that is *opposite to the gloomy and morose*. The pleasant universal '*aloha*' or salutation, the *merry ringing laughter* of the women wherever found, proclaim the people to be a *light-hearted race*."

Taking the whole of these differences, they appear to indicate a radical diversity of race, not to be overcome by any mere similarity of colour and some common words in language, which is all that really exists to prove identity of race. The one single fact of stature is conclusive against any such comparatively recent common origin as M. Quatrefages argues for. A race which averages 5 ft. 10 in., and has many men 6 ft. 2 in. or more, can hardly have been derived, at such a recent period as to have retained community of language, from a race averaging 5 ft. 5 in. or 5 ft. 6 in., and among whom a single individual of 5 ft. 10 in. is rarely, perhaps never, found. Again, the hair of the Malay is of the true Mongol type—black, coarse, and perfectly straight. The least approach to wavy or curly hair is never found among the unmixed Malay. I cannot find evidence that the Polynesians *ever* have this character of hair, while it is undoubtedly often as frizzly as the most decided Papuan. Again, the mental character of two races in a parallel state of civilization and inhabiting very similar countries, is surely of great importance; yet, what contrast can be greater than between the phlegmatic, suspicious, undemonstrative Malay, and the active, frank, and joyous Tahitian? Are we to throw down all these barriers of diversity for the sake of solving by main force a problem that is probably insoluble?

3. *Geological and Zoological Evidence*.—M. Quatrefages dismisses with a very brief notice the proofs of a former much greater extent of land in the Polynesian area than now exists. These proofs are of two kinds: first, the existence of numerous groups of coral islands, which are admitted to indicate sunken land; and secondly, the distribution of animals in the existing islands. That coral reefs and atolls are proofs of a subsidence of the land, has never been seriously denied since Darwin's work on Coral Reefs was published; and as immense areas of the Pacific are occupied by such coral islands alternating with volcanic groups and such as show signs of elevation, it is only a question of time as to whether man could have inhabited these sunken lands.

Can we form any notion how long it is since the Pacific lands have disappeared? This can perhaps be approximately determined by the existing distribution of animals in these islands. The only group we yet know with any approach to completeness are the Birds; and though these may not be supposed to be the best adapted to test a question of this kind, yet ornithologists know that a very moderate extent of ocean practically limits the range of most land birds. The total number of species found in any of these islands is very small. For example, if we exclude the waders, swimmers, and birds of prey as having roving habits and great powers of flight, we find that according to the best information only twenty-two species of land birds inhabit the group of the Society Islands, and of these seven are found in other groups ranging as far as the Marquesas, the Fiji Islands, and even to the Sandwich Islands. These are almost all birds of moderate powers of flight and such as inhabit the forests and mountains, and do not generally range far. In Mr. G. R. Gray's list of the birds of the Pacific Islands I find eleven species of the genera *Myzomela*, *Meliphaga*, *Tatare*, *Monarcha*, *Coriphilus*, *Eudynamis*, and *Ptilonopus*, which are known from two or more of the distinct and well separated groups of islands in the central Pacific, and some of them have a very wide range. Among these are two very distinct genera, *Tatare* and *Coriphilus*, which are entirely confined to the Polynesian area. Now these facts would certainly indicate a more intimate connection of the various groups of islands within the period of living species, and therefore within the human period, than now exists. The phenomena presented by the distribution of man are thus to some extent reproduced by the distribution of land-birds in the same area, and entitle us to believe that the subsidence of land indicated by coral reefs took place since man inhabited the earth. This subsidence was probably coincident with, perhaps caused by, the elevation of the existing volcanic islands; and while man and birds were able to migrate to these, the mammalia dwindled away and finally perished, when the last mountain-top of the old Pacific land sank beneath the Ocean.

This hypothesis is one which does not outrage nature, as does that of the direct and recent derivation of the Polynesians from the Malays. It harmonizes at once with the Geological, the Zoological, and the Anthropological phenomena; and if it is held that the facts are not sufficient to prove it, or that even if proved it only removes the origin of the race in question one step further back into the obscurity of the past, it may be suggested that in a case of such admitted difficulty we can hardly do more. We ought not to expect that the beginnings of every race are to be discovered within the short epoch of human history or tradition, and we have every reason to be suspicious of the theory that professes such a discovery. In the present case, the very erroneous views prevalent on the subject arise from two causes. One is the occurrence of a number of Malay words in the Polynesian language; the other, the similarity of the brown tint of the Malays and Polynesians, while they are separated by a group of people of a much darker colour. The similarity of tint has led many travellers in the one area to jump to the conclusion that the people of the other area, of which they have little knowledge, are the same race. It unfortunately happens that not a single traveller appears to be well acquainted with both races, and for that reason their opinions as to the similarity of the two should be received with great doubt. If, on the contrary, my account of the physical and mental characteristics of the Malays be taken as correct (and I resided among them for eight years), and if it be compared with that of the Polynesians given by Cook, and by recent travellers and missionaries, the differences will be seen to be so striking and radical, that all idea of their being the same race must be given up. In the case of the Malays in particular, much confusion has arisen from travellers having confounded with them the many peoples of distinct race which inhabit the eastern parts of the Malayan Archipelago, such as the Timorese, the mountaineers of Ceram and Gilolo, and of the small islands near New Guinea; and this mistake has been rendered excusable by the number of half-breeds between the two races to be found everywhere. Many of these people are, perhaps, allied to the Polynesians,* but they are certainly not Malays, who are essentially a Mongol race, with many of the Mongol characteristics very strongly marked. The Papuans of New Guinea form the extreme type of another and a widely different race, and all the evidence goes to show that in every characteristic except colour, the Polynesians are nearer to the Papuans than they are to the Malays, although it is not improbable that they are equally distinct from both.

IV. LOUIS FIGUIER.

There are two distinct classes of scientific writers whose labours tend to raise the intelligence of our age; those who, by the publication of original researches (usually in the Transactions of Scientific Societies, or in the pages of technical journals), constitute the pioneers of scientific progress, and by their industry extend our knowledge of the laws of nature; and those again, who, appreciating the value of such original researches, and feeling the necessity for diffusing knowledge amongst the masses in a form in which it will be best understood by them, bring their literary powers to bear in a noble cause, and render comprehensible to the multitude laws and facts which would otherwise be appreciated only by the limited circle of what we are accustomed to call "Savans." Each of these two classes has its work to do, but unfortunately neither sufficiently appreciates the efforts of the other. The originator or discoverer of new facts and theories is too apt to regard the popular exponent of those laws as a "hanger-on of Science," pilfering where he cannot honourably gain; whilst the accomplished littérateur, to whom the patient investigator owes it that he and his newly discovered data are not consigned to oblivion in the archives of some learned but little known society, often entertains slight respect for the man who has but one idol besides science, and that is himself.

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* The mountaineers of Gilolo and Ceram are perhaps true outliers of the Polynesians, and may represent the effect of that *westerly* migration from Samoa, of which Mr. Pritchard speaks.

Of course there are many noble exceptions to this rule; and every day we find the number increasing. Men of research are beginning to cultivate their literary powers, whilst clever writers find it necessary to devote a larger amount of time to mastering the facts of science; and thus we have in every branch men who combine the rare talents of correct thought, careful investigation, and poetic expression; and the sooner all scientific men become sufficiently modest to appreciate the fact that they can best serve their noble calling by condescending to consult the tastes and feelings of the masses, or by availing themselves of the services of those who *can* gain the ear of the multitude, the sooner will science assume its true rank amongst the various branches of human intelligence, and its professors will cast away that stigma of vanity and self-conceit which often attaches itself to them.

Louis Figuier is one of those men whose ardour in the work of popularizing Science seems to know no bounds. Nothing comes amiss to him. He animates the dead and silent rocks, transports his reader with equal facility to the mute age of extinct Saurians, and to the tropical forests of to-day, alive with the songs of their feathered denizens.

Now, he conveys him on the wings of thought to the distant Coal period, lighting the way with the bright facts of Science; now, he descends with him into the Coal regions of our own time, initiates him into mysteries of the collier's craft, and relates in glowing terms how the precious fuel has been utilized to conquer the elements, to minister to man's tastes, desires, and necessities. To-day we may, if we choose, speculate with him upon the appearance of primeval man, whilst he was still struggling for supremacy with the hairy elephant, the hyena, and the cave-bear,* to-morrow we may observe with him how the hardy labourers of Spain or Algeria are engaged in stripping the bark of the Cork-tree.*

Not, however, that his scenic representations always render his scientific views quite comprehensible to us, or satisfy us that he is quite clear on all debated points himself; the strange jumble of Genesis and Geology, of the placid Garden of Eden and the wild Flint-folk, point to an element of superstition which it is to be regretted should have found its way into a work intended to enlighten the populace, and convey the results of advancing science.

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* See Plates.

M. Figuier (Guillaume Louis) was born at Montpellier, 19th February, 1819, and is the son of a chemist, and nephew of a professor of chemistry in that town.

He was admitted as Doctor of Medicine at Montpellier in 1841, and then removed to Paris with a view to study chemistry, which he did under M. Balard (of the Institute). In 1846 he was nominated by the Minister of Public Instruction to the post of Professor in the School of Pharmacy at Montpellier, and returned to his native town, where he remained five years engaged in his professional avocations. In 1850 he obtained the degree of Doctor of Physical Science at Toulouse; in 1853 he returned to Paris and secured a vacant Professorship in the School of Pharmacy, by competition; and from that time to the present he has been occupied either in original researches, chiefly in chemico-physiology, or in the compilation of popular scientific works. Of these the best known in England are naturally those which have been translated into our own language, and we now mean to devote a few pages to their consideration.

In his 'World before the Deluge'* M. Figuier, consistently with the views of modern men of Science, adopts the nebular hypothesis as his cosmical theory; but although he seeks to state it as fairly as possible, yet seeing that his nationality precludes him from following the latest researches of English physicists, and that Mr. Bristow, his able translator and editor, is a mineralogist, and not a student of physical science, we think it would have been better if he had passed over the hypothetical, and leaving the nebular theory to take care of itself, had commenced at the beginning of known Geological history.

It must not be supposed, from these remarks, that we object to the original speculations of professed geologists as to the origin of the earth, for these must necessarily precede or accompany the determination of the true character of its constitution, but in the volume before us we find the hypothesis, as enunciated in the 'Fortnightly Review,' of Mr. Tyndall put forward in support of the nebular theory, whilst the solid researches of Balfour Stewart, Miller, and Huggins are left unnoticed. It may be as clear to M. Figuier or to Mr. Bristow, as it is to Mr. Tyndall, that the luminiferous ether is infinitely more attenuated, but more solid, than gas; and "rather resembles jelly than air;" but if the author or translator had described the experiments of Stewart to show that probably there *is* an ether, and those of the eminent spectroscopic observers of the nebulæ, Huggins and Miller, which point to the existence of still unformed systems, his readers would have had sound scientific facts to guide them, and would have been able to compare them with the well-established data of astronomers.

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* 'The World before the Deluge,' by Louis Figuier; a new edition: the Geological portion carefully revised and much original matter added by Henry W. Bristow, F.R.S. Thirty-four Full Page Illustrations of extinct animals and Ideal Landscapes of the Ancient World, by Riou; and 202 other figures. London: Chapman & Hall.

As the matter stands at present, the arguments of M. Figuier or his translator are based to a large extent on hypotheses, which operate like a double-edged sword.

For example, the central heat of the earth inferred from the existence of volcanoes and hot springs in so many parts of the globe, and from the increase in the temperature of 1° Fht. for every 60 feet descent, is a very plausible argument in favour of the original state of igneous fusion, of which these phenomena seem to be but traces, but it is no proof. Although this increase in temperature as we descend is stoutly denied by some, yet it seems to be generally admitted; but the question still remains, could this state of fluidity exist at the centre consonant with the undoubted immense pressure of the circumference? Sir Charles Lyell* says:—"This theory seems wholly inconsistent with the laws which regulate the circulation of heat through fluid bodies; for if the central heat were as intense as is represented, there must be a circulation of currents tending to equalize the temperature of the resulting fluids, and the solid crust itself would be melted. Instead of an original central heat, we may, perhaps, refer the heat of the interior to chemical changes constantly going on in the earth's crust; for the general effects of chemical combination is the evolution of heat and electricity, which, in their turn, become sources of new chemical changes."

When Sir Humphry Davy succeeded in isolating the metals potassium and sodium, it was supposed that immense quantities of unoxidized metals might exist at great depths; and when water percolating through the rocks gained access to these masses, oxidation of the metals took place with the evolution of intense heat sufficient to melt neighbouring rocks, the hydrogen of the water would escape in the direction of least resistance, carrying with it molten lava, and producing the ordinary volcanic phenomena. Dr. Daubeny also supports this view, and there can be no doubt that chemical operation going on in the interior of the earth is sufficient to produce volcanic action of any degree of intensity.

With regard to the origin of life on our globe, M. Figuier does not dogmatize:—"Did plants precede animals, we cannot tell, but such would appear to have been the order of creation." Our globe, he thinks, during the Cambrian and Silurian periods was not yet mature enough for the existence of the higher organisms. "A pale sun struggling to penetrate the dense atmosphere of the primitive world, and yielding a dim and imperfect light to the first created beings as they left the hand of the Creator, organisms often rudimentary, but at other times sufficiently advanced to indicate a progress towards more perfect creations." The absence of organisms more advanced in the zoological scale than were the Trilobites, is no proof that more highly organized animals did not exist on the globe during the Cambro-Silurian period. Those who think the Darwinian theory approximates to the truth, and especially those who hold the "complete" theory, will of course believe that animals classed as high among the Vertebrata as the Trilobites and Cephalopoda of Lower Silurian rocks are among the Annulosa and Mollusca, existed at that time in regions of the globe from which the ocean, perhaps, for ever excludes the inquiring palæontologist from verifying his conjectures. The discovery of the Eozoon Canadense in the Laurentian rocks, and the existence of beds of limestone in the same system, seem to confirm the views of those who regard the whole of the Sedimentary rocks, from the Silurian and Cambrian upwards to the latest Tertiary beds, as including but a partial and fragmentary record of the past life of the globe—impressions of the last-formed links of the great chain of organic life on our planet—a few of the last chapters in the book of 'Ancient Life.'

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* 'Principles,' 9th edition, p. 545.

Limestone is almost in every case, especially when found existing over extensive areas, the result of organic agency, having been formed from the remains of marine animals, such as corals and various molluscs. Limestone is never a deposit from solution except in fresh water, and over very limited areas. Sea-water is computed to contain much more carbonic acid than is necessary to keep the lime existing in it in solution; so that when we find a limestone in a very ancient formation, although we may not be able to detect any fossil remains, yet we may reasonably infer that it is the result of organic agency.

The author describes the character and geographical extent of the rocks of the Cambrian, Silurian, and Old Red Sandstone periods; and enumerates and describes the typical species of each formation. He is particularly happy in his verbal pictures of those periods, as well as in that of the succeeding Carboniferous era. The author's efforts in this direction have been ably seconded by the artist, whose pictures of the animal and vegetable life of each period are admirably executed; indeed all the plates in the book are splendid specimens of wood-engraving, and are well printed, as will be seen from the accompanying specimens, for which we are indebted to the kindness of M. Figuier's English publishers. The student will find the restorations of extinct animal and vegetable life of much value, whilst the general reader will be no less instructed at beholding such vivid representations of the manner in which nature decked the earth at various times during a period of untold ages.

The author seems to think that the internal heat of the earth affected the temperature of the surface almost as much during the Carboniferous period as it had done during the Silurian epoch. Indeed, he imagines that our planet did not experience what we call climate, until the commencement of the Tertiary period. "It is a remarkable circumstance," he says,* "that this elevated temperature combined with constant humidity does not seem to have been limited to any one part of the globe; the heat seems to have been nearly the same in all latitudes from the equatorial regions up to Melville Island in the Arctic Ocean, where in our days eternal frost prevails; from Spitzbergen to the centre of Africa, the Carboniferous flora is identically the same. When nearly the same species, now extinct, are met with under the same degree of development at the equator, as at the pole, we cannot but admit that at this epoch the temperature of the globe was alike everywhere. What we now call climate was then unknown, in geological times. There seems to have been only one climate over the whole globe. It was only at a later period, that is in Tertiary times, owing to the gradual cooling of the globe, that the cold began to make itself felt at the terrestrial poles. Whence then proceeds this uniformity of temperature which we now regard with so much surprise? It was a consequence of the excessive heat of the globe; the earth was still so hot in itself that its own innate temperature rendered the heat which it received from the sun superfluous and inappreciable." That there existed a uniformly high temperature over the whole globe, during the Carboniferous period, does not necessarily follow from the character of the vegetation alone. That a mild equable climate prevailed at that time rather than a very elevated temperature is the more reasonable inference: and we refer the reader to 'The Principles of Geology,'† for an admirable dissertation on the causes that might bring about such a universally equable climate. The same inference concerning a general prevalence of a high temperature over the earth might seemingly be drawn from the nature of the plants of the Miocene period, found in Iceland, North America, and Greenland, within the Arctic circle. Professor Ramsay,‡ speaking on this subject, remarks, "The meaning of this is not yet understood, for many of the plants are of a nature that seem to bespeak a warmer climate than that of the British Islands at the present day, and it is difficult to see how such plants could grow in Arctic regions, where there is not the stimulus of light during half the year. This is one of those things which we cannot explain, and about which we are waiting for light." Speaking of the genera of Carboniferous plants, Sir Charles Lyell§

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* P. 120.

† Ninth edition, p. 92.

‡ 'Physical Geography and Geology of Britain.'

§ 'Principles,' 9th edition, p. 87.

says, "These were formerly considered so closely allied to tropical genera, and so much greater in size than the corresponding tribes now inhabiting equatorial latitudes, that they were thought to imply an extremely hot as well as humid and equable climate. But recent discoveries respecting the structure and relations of these fossil plants have shown that they deviated so widely from all existing types in the vegetable world, that we have more reason to infer, from this evidence, a widely different climate in the Carboniferous era as compared to that now prevailing, than a temperature extremely elevated."

With regard to the physical formation of the beds of coal, M. Figuier embraces the theory generally accepted, that the plants grew and decayed in the places in which we now find the coal, and were not drifted from a distance.

He concludes his account of the primary rocks with a description of the Permian strata, and of the life of the Permian period. An awkward fact for the consideration of those who defend the theory of a high temperature in the crust of the earth itself at this epoch is thus noticed:*—"Although the Permian flora indicates a climate similar to that which prevailed during the Carboniferous period, it has been pointed out by Professor Ramsay as long ago as 1855, that the Permian breccia of Shropshire, Worcestershire, &c., affords strong proofs of being the result of direct glacial action, and of the consequent existence at this period of glaciers and icebergs. That such a state of things is not inconsistent with the prevalence of a moist, equable, and temperate climate, necessary for the preservation of a luxuriant flora, like that of the period in question, is shown in New Zealand, where, with a climate and vegetation approximating to those of the Carboniferous period, there are also glaciers at the present day, in the southern island."

We can see no analogy between the climate of New Zealand and the state of things described by M. Figuier as existing during the Carboniferous age, although there can be little doubt that the actual climatal condition of the greater part of the earth during Carboniferous and Permian times was something similar to that prevailing in New Zealand at the present day. That glaciers could not exist upon a surface having an elevated temperature, due to the conduction of heat from beneath, is self-evident.

The close of the Primary epoch was, he supposes, marked by local convulsions and disturbances of the globe; but we need not recur to any general cataclysm to explain the passages from one epoch to another, for we have seen, almost in our own day, certain species of animals die out and disappear gradually.

The life of the globe during the Palæozoic ages was characterized by very peculiar forms, both in the animal and vegetable kingdoms. The Graptolites and Cystidea of the Silurian rocks, the numerous genera of Trilobites, the bony-plated fishes of the Old Red Sandstone, and other curious forms, are exclusively confined to this period. The Rugose corals, with one exception, are likewise Palæozoic. Whilst the predominance of Brachiopoda among the Mollusca and of Crinoids among the Annuloida, gives a very marked character to the life of the period. Cryptogamic plants of strange forms and unusual size are most abundantly met with; and the microscopic structure of coal indicates that Gymnospermous Exogens were at this time plentiful.

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* P. 153.

In treating of the Secondary Epoch, M. Figuier adopts that arrangement which divides it into three systems or periods, *viz.* Triassic, Jurassic, and Cretaceous, with the Penarth or Rhætic sub-period, intervening between the Triassic and Jurassic systems, of which a concise and interesting account is given; and for this description the reader is probably indebted to the talented translator, Mr. Bristow.

The numerous remains of gigantic Saurians found in the rocks of the Secondary Epoch have led geologists to name it the *Age of Reptiles;* but the recent discovery of several genera of this class, in the coal measures of Kilkenny, in addition to remains and traces of reptiles previously found in Primary rocks, tends very much to do away with this term, and to deprive the Secondary Epoch of that almost peculiar feature which seemed to belong exclusively to it. The immense number of species of the general *Ammonites* and *Belemnites* seems now to be the only positive peculiar feature in the known life of this epoch. The absence of Mammalia higher than the Marsupial type rests, so far, upon negative evidence, and every advance in geological discovery proves the fallacy of reasoning on the non-existence of the higher forms of that or any other class from such data.

M. Figuier describes the lithological character of the rocks of each successive formation of this epoch. He enumerates the chief species of animals and plants, gives much information relative to the extent, condition, and development of these Secondary rocks, and describes minutely the structure and habits of such enormous reptiles as the *Ichthyosaurus*, *Megalosaurus*, *Plesiosaurus*, and *Iguanodon*, as well as the strange *Ramphorhynchus* and *Pterodactylus*. The non-scientific reader cannot fail to have his curiosity awakened to the study of geology by reading of an animal (the *Ichthyosaurus*) having "the snout of a porpoise, the head of a lizard, the jaws and teeth of a crocodile, the vertebræ of a fish, the sternum of the *Ornithorhynchus*, the paddles of a whale, and the trunk and tail of a quadruped."* Conflicts amongst enormous *Iguanodons* and *Megalosauri*, and angry meetings between strange looking *Ichthyosauri* and *Plesiosauri*, depicted with startling vividness by the artist, who presents us with vigorous and life-like pictures of the periods under consideration, will call to mind the fabled monsters of the Ancients—

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* P. 197.

"Gorgons and Hydras and Chimæras dire."

The late Professor E. Forbes's division of the stratified rocks into Palæozoic and Neozoic will probably be ultimately adopted, instead of Palæozoic, Mesozoic, and Caïnozoic. M. Figuier considers the Caïnozoic strata under the heads of Tertiary and Quaternary, including in the Tertiary, the Eocene, Miocene, and Pliocene formations, and in the Quaternary period describes the Postpliocene, and Recent Deposits. This portion of the work calls for no special remark. The plant-life of the globe at this period, as well as during the Secondary era, is not lost sight of, and is prominently discussed. Amongst the engravings are restorations of the chief Tertiary Mammals; those of the Eocene period so well known in connection with the name of Cuvier; and the gigantic Dinotherium is represented as an elephant with recurved tusks proceeding from the lower jaw. Recent discoveries, however, would seem to call for a considerable modification of our views respecting the affinities of this huge mammal, for further remains of this animal, lately found, are undoubtedly of a Marsupial character.

The principal features in the account of the Quaternary period are the descriptions of the "European deluges," the Glacial epoch, and the Asiatic deluge. The first of these deluges was caused by the sudden upheaval of the Scandinavian mountains: "as the regions in the midst of which this great mountainous upheaval occurred, as the sea surrounding these vast spaces were partly frozen and covered with ice, from their elevation and neighbourhood to the pole, the wave which swept these countries carried along with it enormous masses of ice. The shock produced by the collision of these several solid blocks of frozen waters (ice?) would only have contributed to increase the extent and intensity of the ravages occasioned by this violent cataclysm. The physical proof of this deluge of the north of Europe exists in the vast covering of unstratified earth which covers all the plains and depressions of Northern Europe."* The second European deluge was occasioned, M. Figuier supposes, by the upheaval of the Alps. We need scarcely say, there is not the least proof of either of these supposed deluges having taken place. All the phenomena attributed to their action are well known to be the result of icebergs formed in the mountain valleys, when the greater part of Europe was submerged, during the Glacial epoch. This part of the work seems to be crude and not well arranged. We find scarcely any attempt made to distinguish these diluvial deposits from those of glacial origin. The task would truly be difficult. That the Glacial epoch came on suddenly is proved, the author thinks, by the immense number of mammoths found frozen in Siberia. On this question again, an acquaintance with Lyell's 'Principles' would be of much service, but we cannot dwell on the subject. He seems to be at a loss, too, for any theory that will explain the existence of this intense cold, which he thinks came on so suddenly. Several astronomical theories are discussed, none of which he adopts. No diminution in the calorific power of the sun took place at this time, nor would any modification of the physical geography of the globe, that he is aware of, be adequate to produce this excessively cold climate; but this is the very direction in which he should have sought for an approximate explanation.

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* P. 367.

From considerations based upon a profound and comprehensive knowledge of the present physical geography of the globe, and the fluctuations in the relative position of sea and land indicated by the history of the sedimentary deposits, Sir Charles Lyell concludes that in past ages of the earth there might be, without reference to astronomical causes, such gradual changes brought about in the physical geography of the globe as to have at one period so high a temperature prevailing all over the earth as to banish all traces of snow and glaciers, even from the highest mountains; and at another such an intensity of cold as might render the whole earth uninhabitable.

In the last chapter of the work M. Figuier treats of the origin of the human race, and of the Asiatic deluge. He does not believe in the ape-origin of man. The first man was placed on the earth by the Creator in the neighbourhood of the Euphrates. "There is no doubt," he says,* "that primitive man passed through a period in which he had to contend for existence with ferocious beasts, and to live in a savage state in the woods and savannas where Providence had placed him; but this period of his existence came to an end, and man, an eminently social being, by combining in groups animated by the same interests and the same desires, soon found means to intimidate the animals, to triumph over the elements, to protect himself from the innumerable perils which surround him, and to subdue to his rule the other inhabitants of the earth." This period in man's history, as it is held by the author, is the subject of one of his illustrations which we have selected for insertion, not, however, as a representation of what may be supposed to have been his appearance at that stage of his existence, but as an example of the admirable illustrations accompanying the work. It is impossible, in the present state of our knowledge, to "restore" man as he appeared along with the hairy elephant, the hyena, and the cave-bear. M. Figuier then describes the cave-deposits, peat-beds, shell-mounds, and lacustrine habitations, and discusses the evidence of the contemporaneity of man and certain extinct animals.

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* P. 407.

The Noachian deluge was the result, he conjectures, of "the upheaval of a part of the long chain of mountains, which are a prolongation of the Caucasus. The earth opening by one of the fissures made in its crust in the course of cooling, an eruption of volcanic matter escaped through the enormous crater so produced. Masses of watery vapour or steam accompanied the lava discharged from the interior of the globe, which, being first dissipated in clouds and afterwards condensed, descended in torrents of rain, and the plains were drowned with volcanic mud. The inundation of the plains over an extensive radius was the instantaneous effect of this upheaval, and the formation of the volcanic cone of Ararat, and the vast plateau on which it rests, altogether 17,323 feet above the sea, the permanent result."*

With this extract we must close our notice of M. Figuier's 'World before the Deluge,' a book which will probably be regarded in future ages as a fair illustration of the mixed views held by the various thinkers of our days on geological and palæontological questions.

Every reader will find something to his taste, and the feelings of none will be outraged by too great one-sidedness. There is the plate of the Garden of Eden, with our first parents and Cain, and the Biblical account of the Deluge for those who cling to tradition, whilst there are calm discussions, well-arranged data, and the beautiful illustrations to support a belief in the antiquity of man and his contemporaneity with the great extinct mammifera. Leaving M. Figuier to render these views consistent with each other, we pass on to his 'Vegetable World,'† an exquisite work, which has just been issued as a companion to the 'World before the Deluge.'

If excellent paper, legible type, beautiful illustrations, and good printing be any recommendation to a book, this work should have an extensive sale. The first part of the volume treats of the structure of the various organs of plants and their functions. Commencing with the root, the various kinds of which are fully described, it passes on to the stem; the varieties, structure, and mode of growth of acrogenous, endogenous, and exogenous stems are clearly explained; buds, boughs, and branches successively engage the reader's attention; a brief notice of the different modes of grafting is given, and the structure, functions, and different forms of the leaf are described in a pleasing manner. "Leaves," he says,‡ "transform themselves into other organs with wonderful facility. It is, in fact, by modification of the leaves that nature produces many essential organs in the life of plants." This law of Morphology is often inaccurately stated.

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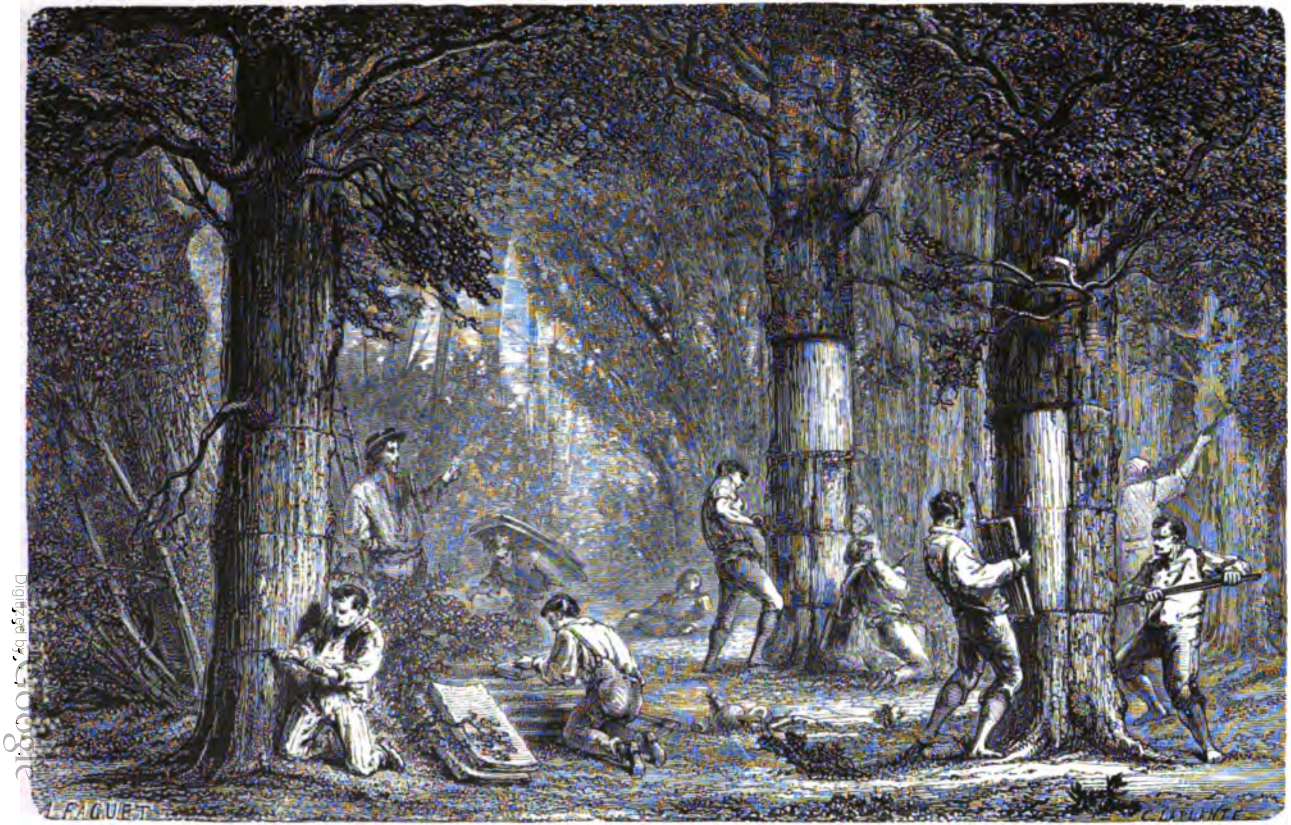
* P. 418.

† 'The Vegetable World: being a History of Plants, with their Botanical Descriptions and Peculiar Properties.' 446 Engravings and 24 Full Page Illustrations, chiefly from Nature. Chapman & Hall, 1867.

‡ P. 83.



Gathering Bark from the Cork Tree.—From Figuier's 'Vegetable World.'

The converse of the first sentence of the preceding extract is frequently observed. A leaf is never transformed into any other organ; but where we should expect stamens, carpels, petals, &c., leaves are often abnormally developed. All the organs of the plant are formed upon a plan, of which the leaf is taken as the type. This doctrine of Goethe has been long recognized by all botanists. And tracing the homologues of the leaf in the various forms assumed by flowers and fruit, constitutes one of the charms of botanical study to the young student.

Exhalation, respiration, and circulation in plants are then glanced at by the author, before proceeding to describe the various parts of the flower and their functions.

The different kinds of inflorescence and varieties of fruits and seeds come under review; and lastly, the interesting phenomena of fecundation and germination are investigated, bringing the portion devoted to organography to a close. The chapter on fecundation is extremely interesting, and is written in a popular style. "When the existence* of sexual differences in vegetables was first propounded, the discovery produced general astonishment. If the most convincing proofs had not established it, if the commonest observation had not allowed every one to verify its reality, it would certainly have been classed among the most singular inventions ever issued from a poet's imagination; but the proofs were convincing. The demonstration of the existence of sexual organs in vegetables became a brilliant and unexpected fact, exhibiting a wonderful analogy between animals and plants, filling up in part the gulf which had hitherto existed between the two great classes of organic beings, yielding an inexhaustible fund of reflection and comparison to naturalists and thinking men.

"The ancients had very vague ideas on this subject. Yet we learn from Herodotus that in his time the Babylonians already distinguished two sorts of Date Palmes. They sprinkled the pollen of one on the flower of the other, in order to perfect the production of the fruit of that valuable tree.

"Cesalpin, an Italian philosopher, physician, and naturalist, who, in the 16th century, was professor of medicine and botany at Pisa, remarked that certain sets of *mercurialis* and *hemp* remained sterile, while others were productive. He considered the first as the male sets, and the second as the female. In the 17th century, Nehemiah Grew, a learned English Fellow of the Royal Society of London, published in 1682 an anatomy of plants; above all, Jaques Camerarius, a German botanist, born at Tübingen, showed the precise use of the two essential parts of the flower, and the part that each plays in producing the fecundation of germs. In a letter now become celebrated, *De Sexu Plantarum*, published in 1694,

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* P. 177.

Camerarius completely proved the great fact of the existence of the sexes in plants just as in animals. This discovery made an impression on the minds of naturalists; it was, in fact, one of the most striking victories which natural science had obtained." *

The portion of the work devoted to systematic botany is preceded by a sketch of the history of botanical science from the time of Aristotle, giving an account of the labours of Grew, Tournefort, Ray, Magnol, Linnæus, Bernard de Jussieu, Adanson, Laurente de Jussieu, De Candolle, Robert Brown, Dr. Lindley, and other great botanists; and it forms a very appropriate introduction to the study of that department of the science. Dr Lindley's son has lately written to the 'Athenæum,' complaining of the unfair use made of his father's works in compiling the 'Vegetable World.' M. Figuier and his editor quote largely from Dr. Lindley's works, and adopt his classification of plants; but their obligations to him are honourably acknowledged in numerous instances, and the translator and editor pays the following tribute to his merits:†—"His knowledge of vegetable structure was extensive and profound. His indefatigable industry and unequalled powers of generalization enabled him to grapple with and bring to perfection the vast scheme of rearranging on physiological principles, after careful structural examination, the whole vegetable world. His 'Vegetable Kingdom' remains a monument of immense learning, technical knowledge, and vast industry. The modern school of botanists may be said, one and all, to have been his pupils, and the system he has framed is probably the nearest to perfection which the world has yet seen." The classification proceeds in the ascending order, commencing with the Diatomaceæ. We should prefer De Candolle's subdivision of the class Exogens into Thalamifloræ, Calycifloræ, Corollifloræ, and Monochlamydæ, to that adopted.

We were somewhat puzzled for a moment at seeing the pages in which the genera Fraxinus, Olea, Solanum, Nicotiana, Atropa, &c., are described, headed "Rosals;" but this is a typographical error, and will, no doubt, be rectified in the next edition.

The engravings, we are told in the preface, are all from nature. They seem to have been drawn from living nature, and not from dried specimens, as sometimes seems to be the case in works on botany.

The concluding portion of the book is on the geographical distribution of plants, and is not the least interesting portion; but want of space prevents us from giving any further extracts, for we have still to deal with M. Figuier's labours in other departments of human intelligence.

Perhaps one of his most attractive productions is after all his 'Merveilles de la Science,' and those who have seen the book will not be surprised to hear that it has had a very large sale in France. It is a work still in progress, and first appears in numbers at 10 cts.

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* P. 177–8.

† P. 220.

each, and then in series; and if some enterprising English publisher would arrange for its republication in England—taking care to add a fuller account of those British inventions to which M. Figuier naturally devotes a more limited space than to those of his own countrymen—we have little doubt that the venture would prove remunerative.

'Les Merveilles de la Science'* is a handsome quarto volume, containing a most agreeable history of the Steam Engine, Steam Boats, Locomotives, Electrical Machines, Lightning Conductors, the Voltaic Pile, and Electro-Magnetism. Doubtless many of his illustrations are fanciful; at least they represent events in the history of Science (such as "James Watt, étudiant le perfectionnement de la machine de Newcomen") which were at the time of so little importance in the eyes of the world, compared with the butcheries of successful generals, that they are not likely to have boasted a special limner; but be that as it may, the sketches of the various scenes on scientific history are very attractive, and are typical of a phase in historical studies not to be met with in any similar work. Were it only for his pleasing reminiscences of the scientific History of Britain, we could not help giving our tribute of admiration to M. Figuier's work, where the reader will find sketches of "Savery in the Tavern," "Humphrey Potter, or the Lazy Genius," "Black making experiments on Latent Heat," various reminiscences of James Watt and the Soho Works, &c.

The foreign scenes are also excellent, and the portraits, commencing with that of Bacon and ending with Ruhmkorff, appear very good, and are certainly of an order hardly to be expected in a serial at ten centimes. When we add that one of the last sketches is that of Wilde's magneto-electrical machine, which appeared in our number of last October, it will be evident that M. Figuier is not unconscious of the latest scientific novelties.

Indeed it is not likely that he ever will be far behind his age as long as he continues to compile and publish another work before us, 'L'Année scientifique et industrielle,'† to which we shall now devote a few closing remarks.

The frontispiece to M. Figuier's "Annual" represents the eruption of the Volcanic Island of Santorin, copied from a photograph, and its contents comprise accounts of all events and discoveries of note in every branch of science, with accounts of the proceedings of scientific societies, and obituaries of eminent men; indeed it greatly resembles our own "Chronicles of Science." M. Figuier should, in future, request some English friend to look over his work, and rectify errors in English names, such as that of Brande, which he spells Brandes, for he must know that the brotherhood between the scientific circles of France and England is becoming more and more intimate every year, and increased accuracy is required in the record of their respective labours.

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* 'Les Merveilles de la Science, ou description populaire des Inventions modernes.' Par Louis Figuier. Paris: Furne, Jouvet & Cie. 1866.

† 'L'Année Scientifique et Industrielle, ou Exposé Annuel des Travaux Scientifiques, des Inventions et des Principales Applications de la Science à l'Industrie, aux Arts, &c.' Par Louis Figuier. (11me Année, 1866.) Paris: L. Hachette & Cie. 1867.

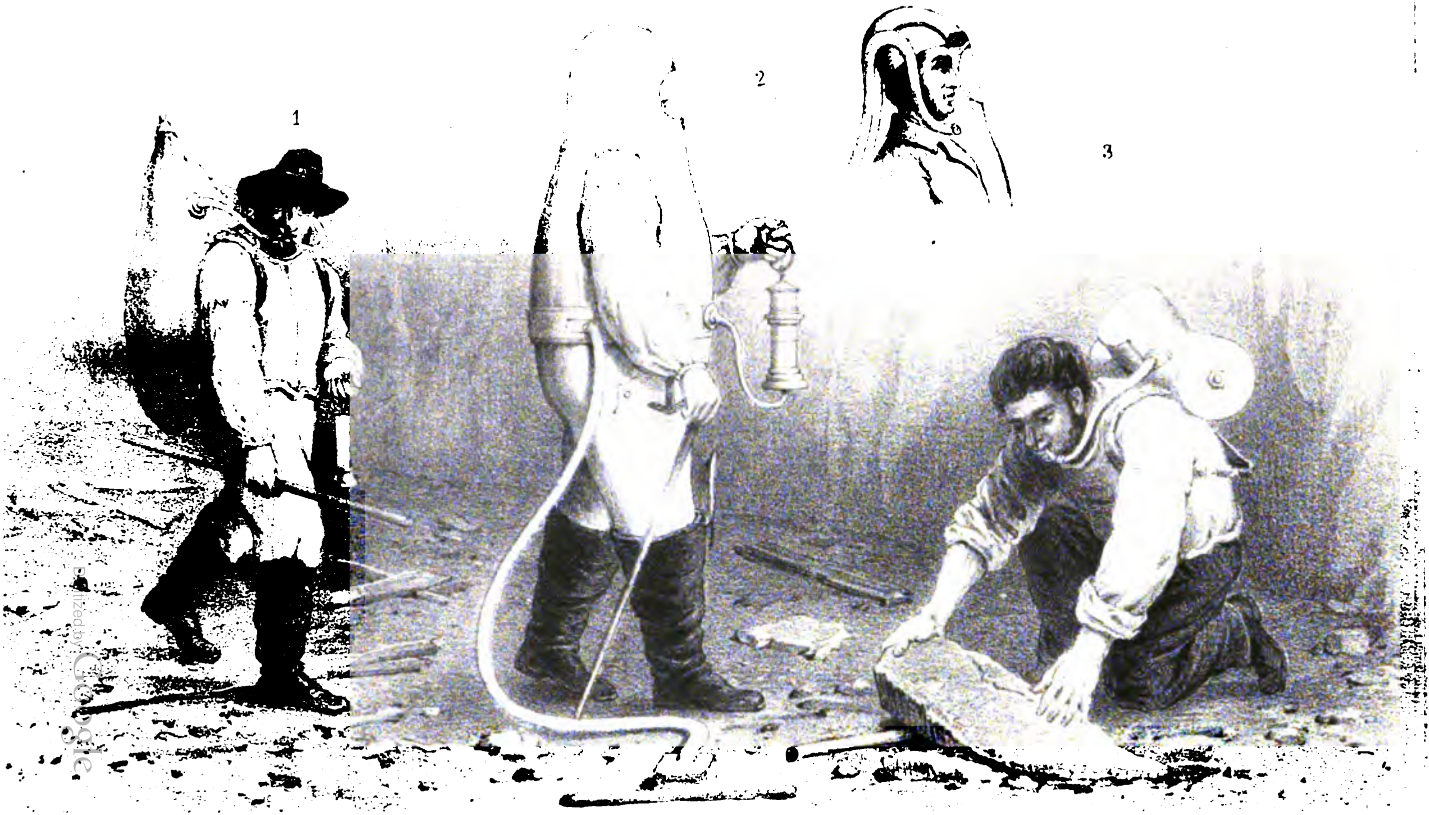
It is to promote the closer union of the scientific men on either side of the Channel that we have chosen M. Figuier as the subject of this memoir. We might, it is true, have selected Frenchmen more deeply versed in some particular branch of science, and better known in our own scientific sphere; but we think that the account we have given of the useful and varied labours of M. Figuier, the favour with which his treatises have been received in England, and the influence they are likely to exercise upon his own vivacious and somewhat volatile countrymen, sufficiently justify our choice in this respect, and we hope to receive many more works from the pen of the same zealous and accomplished author.

V. THE VENTILATION OF COAL MINES.

By Robert Hunt, F.R.S., Keeper of the Mining Records.

The terrific explosion of fire-damp in the Oaks colliery near Barnsley, by which more men were killed than were ever sacrificed in any mine in the world at one time, and the scarcely less sad calamity at the Talk-o'-th'-Hill colliery in North Staffordshire, have forcibly drawn attention to the modes employed for the extraction of coal from the inclosing rocks. The results of the inquiries instituted have served to prove that, in the colliery where the greater number of lives were lost, all the arrangements were such as would be produced under the most satisfactory management; whilst in the other there were evidences of neglect arising from the lax system of discipline which prevailed. Therefore, in re-examining the question of ventilation—which appears necessary, since we desire to remove some of the numerous errors which prevail—we may keep before us with advantage these Yorkshire and Staffordshire collieries as representing respectively a good and an imperfect system of coal-mining.

The Inspector's reports, which have been published regularly for ten years, inform us that about 1,000 men are killed annually in this country, in raising our coal from its bed. This has been long known, but, excepting by those who are directly brought in contact with the coal-mining population, it has passed unheeded. It is only when a great catastrophe occurs—and scores, or it may be hundreds, of men are killed—that public attention is aroused, and directed to



APPARATUS USED FOR PENETRATING DANGEROUS GASES IN MINES

the lamentable fact, that the agent which gives us so much comfort at home, and which enables us to maintain our manufacturing and commercial supremacy abroad, is obtained at such a mournful cost. Men then ask one of another, cannot this be prevented? and many an active mind, perfectly innocent of any knowledge of the conditions of a coal-mine, at once favours the world with crude suggestions. Floods of letters appear in the newspapers, many of them indicating the strongest possible desire to do good, but at the same time most of them show a want of that acquaintance with the physical facts and the mechanical appliances, which must be closely studied and familiarly known, ere any—even the least—improvement can be hoped for, in the practice of coal-mining. Nor is our legislature free from this spasmodic effort to effect a good. For years the reports of Her Majesty's Inspectors have been laid on the table of the House of Commons. They have regularly told the tale, which we now repeat, and yet no member has felt sufficiently interested in the matter to make an earnest effort to secure a better state of things.

We are indebted to Mr. Atkinson, H. M. Inspector of Collieries for Durham, for the following compilation, showing the results of fatal accidents which have occurred during the last ten years.

	Tons of Coal raised.	Miners killed by—			
		Explosions.	Falls of roof.	Shafts.	Miscellaneous.
1. Northumberland, Cumberland, and North Durham	92,825,433	186	308	118	529
2. South Durham	126,240,072	48	292	110	359
3. North and East Lancashire .	59,991,875	238	268	132	148
4. West Lancashire and North Wales	70,442,000	169	358	227	216
5. Yorkshire, Derbyshire, and Nottingham	89,616,315	340	238	130	79
6. Leicester and Warwick . . .	60,980,319	52	228	115	150
7. North Stafford, Shropshire, and Cheshire	41,900,000	121	202	156	112
8. South Staffordshire	76,483,405	126	745	319	112
9. Monmouthshire, Gloucestershire, and Somersetshire	52,894,500	231	354	96	102
10. South Wales	64,951,136	412	530	123	292
11. East District of Scotland . .	54,208,000	27	216	93	82
12. West District of Scotland . .	59,082,897	69	214	91	53
Total	849,615,952	2,019	3,953	1,710	2,234

SUMMARY FOR TEN YEARS.	No.	Per cent.
Deaths from fire-damp explosions	2,019	20·36
Falls of roof and coal	3,953	39·87
Shaft accidents	1,710	17·24
Miscellaneous accidents in mines and above-ground	2,234	22·53
	9,916	100 00

A close examination of these returns gives the following mean annual average of miners killed, by each class of accident, in each inspector's district.

	Explosions.	Falls of Roof.	Accidents in Shafts.	Sundry Causes.	Total in each District.
1. Northumberland, North Durham, and Cumberland	30·1	33·0	12·1	59·3	135·5
2. South Durham	6·2	34·0	9·4	20·2	69·8
3. Lancashire N. and E. Division .	11·3	27·1	12·2	10·3	60·9
4. Lancashire W. and North Wales	19·0	34·3	19·1	11·2	83·6
5. Yorkshire	21·2	25·0	13·0	7·2	66·4
6. Derbyshire, Nottinghamshire, Leicestershire, Warwickshire	2·4	22·1	10·4	14·1	49·0
7. North Stafford and Cheshire .	9·0	20·0	22·0	8·1	59·1
8. S. Stafford and Worcestershire .	11·4	75·3	31·3	10·1	128·1
9. Monmouthshire, Gloucestershire, Somerset, and Devon	31·4	35·0	8·0	7·3	81·7
10. South Wales	33·1	55·1	11·0	25·1	124·3
11. Scotland E.	2·2	23·4	9·3	5·0	39·9
12. Scotland W.	6·2	22·3	8·2	3·2	39·9
	163·5	406·6	167·0	181·1	918·2
Ironstone Mines in connection with coal-fields	6·1	40·0	30·0	15·0	91·1
Total	169·6	446·6	197·0	196·1	1009·3

1. The number of accidents involving loss of life in each year . 851
2. The number of lives lost in each year by the above accidents 1009·3
3. The number of collieries in the United Kingdom 3,256
4. Accidents therefore occur annually at rather less than one-third of the collieries.
5. A life is lost annually at one-third of the collieries.
6. Quantity of coal raised annually . . . . 98,000,000 tons.
7. Therefore a life is lost for, of coal raised . . . . 97,135 ,,
8. Value of the coal raised at pit's mouth £24,500,000
9. A life is lost in the production of coal valued at . £24,390

We learn also from this examination, that explosions of fire-damp are not the most frequent causes of death. There are killed in each year:—

By explosions of fire-damp	169·6
Falls of roof	446·6
Accidents in shafts	197·0
Sundry causes	196·1
	1009·3

Of course, the loss of nearly 400 lives in the two terrible explosions of last year will greatly elevate the average for some years to come. But the Barnsley explosion must, in its disastrous results, be regarded as an exceptional case, as we shall endeavour to show.

With great industry Mr. Wm. Green, jun., has collected

"Chronicles and Records" of the Northern coal trades. This carries us back to 1180, and gives a table of accidents. We have since 1658* imperfect and intermittent records of the colliery explosions, and when the workings in our collieries were far less extensive than they now are, we find some very serious accidents.

At Fatfield colliery, in Durham, in 1708, sixty-nine lives were lost; and in 1710 between seventy and eighty perished in the Bensham colliery. Until towards the end of the last century the lists of accidents are few; not that they did not occur, but it was thought unwise to report them. In 1767, we find in the 'Newcastle Journal' the following curious paragraph:—"As so many deplorable accidents have lately happened in collieries, it certainly claims the attention of coal-owners to make provision for the distressed widows and fatherless children occasioned by these mines, as the catastrophes from foul air become more common than ever. Yet, *as we have been requested to take no particular notice of these things, which, in fact, could have very little good tendency, we drop the further mentioning of it.*" This paragraph appeared on the 21st of March, and, on the 27th of the same month, a second explosion occurred at Fatfield colliery, already mentioned, by which 39 men were killed.

Since that period the most serious accidents from explosions, in the great Northern coalfield, have been the following:—

1778.	Chartershaugh	Colliery	24	lives lost.
1794.	Picktree	„	30	„
„	Harraton	„	28	„
1799.	Lumley	„	39	„
1805.	Oxclose	„	38	„
	Hebburn	„	35	„
1812.	Felling	„	92	„
1813.	Fatfield	„	32	„
1815.	Newbottle	„	57	„
1817.	Harraton	„	44	„
1821.	Wallsend	„	52	„
1823.	Rainton	„	59	„
1830.	Jarrow	„	42	„
1833.	Springwell	„	47	„
1835.	Wallsend	„	102	„
1839.	Hilda Wallsend	„	52	„
1844.	Haswell	„	95	„
1845.	Jarrow	„	40	„
1849.	Hebburn	„	31	„
1851.	Wallsend	„	34	„
1860.	Burradon	„	74	„
1860.	Risca Black Vein	„	142	„

In 1815, 75 men were drowned in Heaton colliery by an inundation, and in 1862, 204 men perished in Hartley colliery by suffocation: the shaft having been closed by the breaking of an immense pumping-engine beam, one-half of which fell into it.

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* 'Transactions of the North of England Institute of Mining Engineers,' vol. xv., 1865–6.

In other districts the most serious accidents from explosions have been the following:—

1852.	Nitshill, Scotland	61	lives lost.
	Gwendreath, South Wales	27	,,
	Middle Dyffryn, Aberdare	68	,,
	Coppul ,,	36	,,
1853.	Bent Grange, Oldham	20	,,
1854.	Warren Vale, Rotherham	52	,,
	Ince Hall, Lancashire	89	,,
1856.	Cymmer, Rhondd	114	,,
1857.	Lundhill, Barnsley	189	,,
1858.	Bardsley, Ashton	53	,,
1862.	Cethin, Merthyr	47	,,
1862.	Edmund's Main, Barnsley	59	,,
1866.	Oaks	about 300	,,
1866.	Talk-o'-the-Hill	91	,,

The examples which have been given show that the coal-miner has to guard against a terrible enemy; and although a larger number of deaths occur in our coal-pits from other causes which demand our most serious attention, it is necessary that, for the present, we should dwell exclusively on the conditions under which fire-damp is formed, and on the methods which are adopted to remove it or render it inactive. This article addresses itself to the intelligent reader who may be desirous of receiving correct impressions upon a subject of great general interest; therefore the student of science must excuse the, to him, rudimentary details, which are thought necessary.

Numerous theories have been, from time to time, promulgated relative to the formation of coal, and many of them have been received, by our most able geologists, as explaining the observed phenomena. No one can deny the vegetable origin of coal; its chemical composition, its physical conditions, and the evidences of embedded plants, are sufficiently satisfactory. But that coal has been formed from woody fibre, rather than from the succulent parts of plants, or from plants containing but little wood, is not by any means so evident. Several microscopic observers have thought that they have detected ligneous structure in coal; but when the same sections have been submitted to the botanist, he has generally decided that no such structure was apparent. This is spoken of the true old coal, and has no reference to Tertiary coal (Bituminous Wood, Lignite, &c.). Goeppert,* to whom we are indebted for many valuable researches on coal, says, "there are but few varieties of coal in which their vegetable origin can be detected by anatomical examination; and even in Tertiary coal the change is so far advanced, that scarcely anything more can be recognized than a few elementary organs." "Coal," writes

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* 'Poggend Annal,' vol. lxxxvi., p. 482.

Bischof,* "consists chiefly of the stems of Stigmaria, Sigillaria, Lepidodendra, and Calamites, in the more or less perfectly preserved bark of which may be recognized the characteristic leaf cicatrices." Wherever these plants have been discovered in our coal-beds, the only portion which has been converted into coal, has been the bark; the woody portion has, by the operation of the law of substitution, become stone, but never coal. The writer of this article has sought over every coalfield of the United Kingdom for an example of wood converted into coal, in vain; nor has he been successful in obtaining such a specimen from any of the coalfields of Europe or America.

It is not denied that woody matter may have played its part in the formation of coal; but if it has done so, every trace of wood has been lost by the changes which it has undergone, previously to its being deposited as part of a bed of coal. It may not be amiss, as showing the chemical evidence adduced, to place together the results of a few analyses, omitting the earthy matter, which exhibit the difference in chemical constitution between Wood, Turf, Lignite, and Coal.

	Carbon.	Hydrogen.	Oxygen and Nitrogen.
Wood—mean composition	49·1	6·3	44·6
Turf from Dartmoor	60·0	6·0	33·8
Brown coal from Bovey	67·9	5·8	24·0
Lignites from the Rhone	74·2	5·9	22·5
Coal, Newcastle	87·9	6·5	12·6

"It may be some time before we fully understand the processes in operation during the conversion of woody fibre into the curious mineral substance, coal. The only way of attaining such knowledge is to examine carefully the gases eliminated during its progressive alterations, and endeavour to follow out the proximate changes which have produced these ultimate products of transformation."† However, without admitting that ligneous tissues have been principally concerned in the formation of coal, which is Bischof's assumption, it is not denied that they may have formed no inconsiderable portion of the vegetable mass, which was to be, by a series of changes, eventually converted into Bituminous Coal.

Vegetable matter in its various stages of decay, and under different conditions, is found to exhibit—

1. The separation of carbonic acid and carburetted hydrogen.
2. " " of carbonic acid and water.
3. " " of carburetted hydrogen and water, or
4. " " of all three.

Consequently, except where the oxidation of the carbon alone takes place, carburetted hydrogen is constantly evolved. The following are a few of Playfair's analyses of the Gases of coal-mines:—

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* 'Elements of Chemical and Physical Geology,' vol. i., p. 260.

† 'On the Gases evolved during the Formation of Coal,' by Dr. Lyon Playfair. 'Memoirs of the Geological Survey of Great Britain,' vol. i., p. 460.

	(1)	(2)	(3)	(4)	(5)	(6)
Oxygen	0·9	..	..	0·6	3·0	..
Nitrogen	6·7	6·4	6·9	14·2	12·3	4·9
Carbonic acid . . .	0·7	1·1	0·3	2·1	2·0	1·7
Light carburetted hydrogen	91·8	92·7	92·8	83·1	79·7	93·4
Hydrogen	..	..	..	..	3·0	..

Consequently we may infer that the production of the light carburetted hydrogen, which constitutes, when mixed with atmospheric air, the explosive fire-damp, is either a continuation of the process by which the coal has been formed, or that during the mutation resulting, eventually, in coal, this gas has been largely developed, and *retained* in the coal-bed, under enormous pressure, and consequently in a most condensed form. Few persons who are not familiar with our coal-beds have any idea of the state of high tension in which the carburetted hydrogen exists in them. Mr. Thomas John Taylor, who was one of the most experienced and scientific of our colliery viewers, stated, before the Mining Institute of Newcastle-on-Tyne, "that the mean annual quantity of gas evolved from a barred-up district of fifty acres, in the Bensham seam at Wallsend colliery, was thirty-four and a half millions of cubic feet, equal to the solid contents of a coal-bed five feet thick and 160 acres in extent."

With this statement before us, it will be readily understood how, when such a reservoir is suddenly tapped, by cutting a fissure or otherwise, the outburst of gas must overpower the best possible ventilation. Coal usually lies in widely extended beds, spread out horizontally, or nearly so. The labours of the miner are directed to the extraction of these beds from their seats, deep in the earth, at the least cost, with the smallest waste practicable, and of course with as little risk as possible. This is effected in several ways, in different districts, the principle observed being—by whatever method the coal may be worked—to prevent the fall of the stratum above the coal—"the roof"—when the coal is removed; and so to arrange the "ways," that a constant current of air may circulate through them. The more common methods are those called respectively "pillar and stall" and "long-wall" working. In the first of these large oblong pillars of coal are left to support the roof, and a colliery so worked may be well represented, by placing piles of books a few inches apart on a table, and covering all of them with a board. The books will represent the pillars, and the spaces between each pile, the passages of the mine. After a period, in such a colliery, it is customary to "draw the pillars," for thus will be obtained a large additional supply of coal. This is effected by removing these oblong supports, beginning at the most remote part of the workings, and allowing the roof to fall in: this forms a waste, commonly called the "goaf" or "gob."*

The "long-wall" mode of working consists in carrying passages to the extremity of the property, and then working away the coal in one long face, supporting the roof by props for a time, and eventually, by walls formed of stone from the mine.

A word or two on mining appears necessary. The order of the operation is this:—The coal is cut and got by "hewers;" it is then moved in the tubs through the first passages by "putters;" horses draw several of these tubs to the shaft-foot, and these are drawn to the surface by the steam-engine. Only one of these processes—the hewers'—has any direct effect on the liberation of gas, but they all have an important bearing on the plan of the underground roads and methods of ventilation. The roof which overlies the cavities made in removing the coal by the hewers may have a tendency to fall in, and pour inflammable gas into the "roadways" or "air channels." The "thill" or floor may, being relieved from the pressure of the superincumbent masses, be subject to heave and discharge gas upwards; there may be in front of the workings, especially along lines of dislocation, undiscovered reservoirs of such gas: it may have accumulated in the broken ground or "goaf" (which has been described), which, once abandoned, is rarely ever explored again. All these may be regarded as sources from which gas may flow, and, under a judicious system of working, they should be carefully guarded against. The main source, however, of inflammable gas, and that which yields by far the greater, but not the most dangerous, supplies, is the cutting of the fresh coal in the ordinary process of every-day work. "It will be observed," says one of the inspectors, "that about three-fourths of the explosions take place in stagnant places in 'winning forward' new drifts, where the openings were in course of being made, and the ventilation not brought close up to the face." This will satisfactorily show that the coal is in its natural condition constantly evolving gas, and that the admission of atmospheric air has nothing to do with the liberation of the fire-damp gas.

Coal is cut by the "hewers" in two directions, at right angles to each other; these are called "boardways" and "headways."

It is found as a matter of experience, that in driving "boardways course" whatever gas exists in the coal comes off more freely from the numerous fissures which *are cut across*. In most seams of coal a definite structure is observable, innumerable small fissures are found to run in a uniform direction, or nearly so; this is called "cleat." In cutting across these fissures, more gas is liberated than when working "headways course," or parallel to those fissures. Thus we learn that gas is not *generated* in the coal during the process of working, or by the release of pressure; but, that it is poured out of cavities, in which it has long been pent up, because these cavities are laid open. The more free and open the cleat structure, the more easy and regular the flow of the released gas.

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* Goaf is equivalent to the *Gob* of the Midland Counties, and the "Vugh," or "Vugha," of the Cornish miners. It is probably of Cymric origin—from "Ogof," a cave or hollow. The *Gogofau*, or *Ogofau*, is the name of a Roman gold-mine near Pumpsant, in Caermarthenshire.

From the quantity of nitrogen detected by Playfair in the gases examined by him, it has been supposed by some that atmospheric air has permeated the fissures of the coal, and set up chemical action; "for we are ignorant of any process of decomposition which would eliminate it in an isolated form. The process of decay and putrefaction would cause its separation as ammonia, and the action of heat would produce the same effect." The presence of carbonic acid—always, however, in small quantities,—which has been detected, has been adduced as further evidence of the action of atmospheric air on the coal, after it has been opened by the miner. These hypotheses are unsupported by the evidence we obtain in the pits. Every stage in the operations of the miner shows that this carburetted hydrogen has been accumulating for ages in the mass of the coal, and that it is liberated in the process of working out the bed of coal.

It should not be forgotten that coal-beds vary very greatly in respect to their gaseous accumulations. There are some districts in which "fire-damp" is unknown. There are even beds of coal which contain much carburetted hydrogen in some parts, while other parts are entirely free from this gas. It is not easy to account for this difference. In all probability, the age of the coal, the conditions under which the coal was formed, and the length of time during which the masses of coal-plants were exposed to atmospheric conditions, before they were buried under the strata of sand and shale which now cover them, determined the physical conditions of the bed.

Some idea may be formed of the rapidity with which the inflammable gases pour forth by an example or two. On one occasion at Seaton-Delaval, 4,900 cubic feet of gas were evolved in three minutes. At Hebburn colliery, where the process was continuous, about 1,500 cubic feet of explosive mixture was formed in two hours. Occasionally the outburst of gas is with explosive violence, overpowering any system of ventilation which can be established.

Such are the circumstances,—very briefly stated,—of the conditions under which the dangerous atmospheres of our collieries are produced. Let us now examine the methods which are adopted to secure the removal of those dangerous gases as quickly as they are formed.

It is well known, that as we descend into the Earth, by means of a shaft, the temperature increases, and it increases in some ratio with the depth. Mr. Edward Hull has given, as the result of observations made in the Duckinfield colliery in Cheshire, an increase of 1° Fahr. for every 83·2 feet in depth. Professor Phillips obtained results in Monkwearmouth colliery which appeared to show an increase of 1° F. for every 60 feet of depth. The results arrived at by Mr. Robert Were Fox, in the deep mines of Cornwall were, that for the first hundred fathoms, the increase of temperature was 1° F. for every 50 feet; in the second hundred fathoms, 1° F. in every 60 feet; and for the third hundred fathoms, 1° F. in every 75 feet: thus showing that the increase was in a constantly diminishing ratio. In addition to the natural heat in a mine, the temperature is increased by the lights employed and by the breathing of the men and horses. Therefore the air, after it has passed through a mine, is of a higher temperature than when it entered. Such heat acting upon the air of a mine rarefies it, and passing into the "upcast" shaft presents a column of air specifically lighter than that in the "downcast" shaft. Thus a continual current of air is produced down one shaft, it travels around the workings, and up another shaft; this constitutes what is called NATURAL VENTILATION. Mr. Nicholas Wood has shown that at Seaton pit, the shaft, having a diameter of 14 feet, equally divided by a timber brattice, airtight from top to bottom, and a depth of 1,560 feet, the length of the air courses being 3,036 feet, by merely natural ventilation 7,002 cubic feet of air passed out of the upcast side of the shaft per minute, the temperature of the air entering the mine, at the top of the *downcast*, being 47° F., and of that leaving the mine, at the top of the *upcast* shaft, 62·5° F. It will be evident to any reflecting mind that the greater the difference between the temperature of the air entering a mine and on leaving it, the more powerful will be the *mechanical* force exerted by the heat. Hence in winter natural ventilation is far more effective than in the summer, at which season the surface temperature is so slightly different from the subterranean, that very little movement takes place.

It being a necessity to secure a constant motion of the air through every portion of a colliery's workings, and for this motion to be of sufficient rapidity to carry off, as quickly as it is evolved, the gas from the coal, an artificial system must be established. The first obvious method would clearly be, to heat the air in one of the shafts, or in one division of the shaft, where one only existed; hence the introduction of furnace-ventilation. The ventilating current is produced by the difference of density between the air passing down one shaft, or one side of a shaft, and that passing up;—the amount of current varying with the square root of the difference of temperature between the columns respectively; so that if it were necessary to double an air-current, the difference of temperature would have to be quadrupled. The amount of current varies with the square root of the depths of the upcast shaft; thus, to double this, the shaft or chimney must be made of four times the original height. Again, the resistance of an air-current increases with the square of the velocity, and inversely as the area of the spaces traversed. These facts show that a furnace being constructed for the purposes of ventilation, and placed under the best possible conditions, cannot, in cases of sudden emergency, be greatly augmented in power.

The principles for securing the greatest advantage from the heat of a furnace are,—first, to maintain as high a temperature as possible in the upcast shaft; and secondly, to place the source of heat—the furnace—at the bottom of the shaft, supplying the fire with air which has not passed through the workings. It has been often argued that greater ventilating power can be obtained by using the return air rather than fresh air to urge the combustion of the coal. This is no doubt true, and in many collieries it may be safely applied; but there is always greater safety in exciting the fire with fresh air, and directing the return air into the heated shaft, without allowing it to pass over the incandescent fuel.

The shaft is a chimney; the higher you can heat that chimney, the more rapid will be the current moving up it. At Hetton colliery, 190,000 cubic feet pass by the furnace in each minute. At Haswell colliery, 100,917 cubic feet; and at Wallsend, 122,000 cubic feet. In these large collieries the extent to which ventilation is carried is necessarily greater than in less extensive works, where the liabilities to the presence of explosive gases are less. In the West Riding of Yorkshire, for example, we find the rate at which air passes the upcast shaft is,—at Ardsley Main, 30,957 cubic feet; and at Darley Main, 30,780 cubic feet.

Some years since, Mr., now Sir Goldsworthy Gurney, introduced what has been called steam-jet ventilation. He found that a jet of steam issuing under pressure, at high velocities, dragged the air forcibly with it. At Seaton Delaval, where this system was admirably applied, the rate of the air-current was found to be 82,320 C. F., and 74,391 C. F., as the average of a great many sets of experimental trials.

Mechanical ventilation must now receive consideration. The machines adopted for the ventilation of mines, although varying considerably in structural details, may all be referred to one or other of two great classes, namely:—1. Those exhausting the air by direct expansion and compression in a cylinder or chest; and, 2. Those producing a vacuum by centrifugal action. The latter includes the various kinds of fans, while the former is represented by the piston and cylinder machines.

The oldest machine of the first class is that which, under the name of the Harz air-pump in Germany, or duck machine in Cornwall, has for centuries past been almost the only artificial ventilation employed in metal-mining. It consists of a square wooden box, open at the bottom, which is moved up and down by a reciprocating rod, in a cistern partly filled with water; a pipe communicating with the working of the mine rises in the centre of the cistern, a little above the level of the water, and is stopped by a valve opening outwards. As the box rises, a partial vacuum is formed within it, into which the foul air from below rises as soon as the difference of pressure is sufficient to overcome the small resistance offered by the weight of the valve. At the return stroke, the aspired air is compressed and drawn out, either through a second pipe communicating with the external air, or, what is more generally the case, through discharging-valves fixed on the top of the box. The use of the duck machine is generally confined to ventilating the end of a single gallery, and for such purposes it is well adapted, being of a simple and inexpensive construction. The power necessary to drive it is usually obtained by attaching it to the main rod of the pumping-engine.

Machines upon this principle have been constructed for colliery ventilation, of very large dimensions, one of the most important examples being that erected by M. Devaux at Marihayes, near Seramy, in Belgium. It has two wrought-iron cylinders or bells, 12 feet in diameter, and 8½ feet high, which are put in alternating motion by a horizontal steam-engine, one rising as the other descends. The cistern is annular, of about 10 inches greater diameter than the bell. The interior space or air-chamber is closed at the top, the air-way being formed by sixteen large balanced valves, opening outwards, a corresponding series being fixed in the roof of the bell.

A modification of this machine, called by the inventor and patentee, Mr. W. P. Struvé, an "airometer," has been in use for some years past in South Wales; the bells are, however, without valves, and are driven by a rotary motion of a reciprocating engine. The intake and discharge valves are in connection with outer cylinders of masonry, one set being placed below and the other above the bells. The whole arrangement is, in fact, an imperfect form of double-acting blast cylinder, having a water-joint instead of tight packing on the piston; but the valves being placed vertically instead of horizontally, allows them to be made much tighter, thus giving an advantage over the more perfectly constructed Belgian machine.

An airometer at Westminster colliery, Denbighshire, with a single bell of 17 feet in diameter and 6½ feet stroke, making eight double strokes, was found to draw 23,608 cubic feet per minute, the average pressure being about 1·41 inches of water.

The single-acting blowing cylinder, with a tightly fitting piston, similar to that formerly employed in forges, was at one time used to a considerable extent in France and Belgium, but does not appear to have been successful. More recently, however, this form has been revived, with the important modification of placing the cylinders, or rather air-chests—a box of square section being usually employed—horizontally instead of vertically, so that the valves may be made of large sectional area without any counterbalance; the pressure against the seat when closed being very much less than is the case in the vertical cylinder. Prominent among this class is that known as Nixon's machine, which has two single-acting boxes and pistons, each 20 feet square, and making a stroke of 30 feet. It is of comparatively recent introduction, and is mostly used in South Wales. The essential conditions for the successful construction of a machine of this class are great lightness in the working parts, and the use of guide rollers to keep the weight of the piston from wearing out the packing unequally.

Fabry's pneumatic wheel and Lemielle's ventilator are examples of machines with cylinders and rotating pistons. The former consists of three horizontal fans, each with three blades, suspended in a pit bounded by walls, forming segments of circles. The air is scooped up by the advancing blades in passing these portions of the pit, and is prevented from returning through the unenclosed portion, by a system of interlocking plates at right angles to the main air-way on the opposite sides of the shaft. Although a comparatively simple contrivance, it is difficult to express its mode of action clearly without illustrative drawings. The amount of air discharged per revolution is comparatively small, with reference to the size of the cylinder described by the points of the blades; but, as it is driven continuously, a steady current can be kept up by working it at a moderate rate of speed.

Lemielle's machine may be best described as a common feathering paddle-wheel, with only two or three float-boards, which is placed eccentrically, and made to revolve in a circumscribing cylinder, provided with intake and discharging passages nearly opposite to each other, the axis of the wheel being placed vertically instead of horizontally. The blades corresponding to the float-boards in the paddle-wheel are kept, by their eccentric rods, in close contact with the wall of the cylinder as the axis revolves, from the moment they pass the intake until they reach the discharging port, where the volume of air included between two following blades passes out into the atmosphere.

The usual dimensions of these machines are as follow:—Diameter of the drum, about 10 feet; of the outer cylinder, 13 feet; length of blades, 7 feet; when making from 20 to 30 revolutions per minute, the effective difference of pressure produced is from ½ to 1½ inches of water.

In the second, or centrifugal, class of ventilators, fans of all kinds have been adopted at different times, both in this country and abroad. Formerly, those with curved blades, arranged so as to discharge the air inspirated from the entire circumference simultaneously, were used in the North of France; but the small effect given by them, when compared with the power expended, has led to their abandonment, and at present the simple forms with straight blades and slightly eccentric drums, similar to the older forms of foundry fans, though, of course, of much greater dimensions, are mostly in vogue. The following are among the more important examples:—

Nasmyth's fan, at Abercarne, has eight wrought-iron radial arms, carrying thin sheet-iron blades 3½ feet wide and 3 feet long, the effective diameter is 13½ feet, the drum, or casing, is open all round, and has two passages in the centre for the admission of the air drawn from the mine. It is driven by a single high-pressure engine, of 12 inches diameter of piston and 12 inches length of stroke, and when making from 60 to 90 revolutions per minute, aspirates from 45,000 to 56,000 cubic feet of air per minute, under a pressure of from 0·5 to 0·9 inch of water.

In Guibal's fan, which is extensively used in the North of France, and has also been introduced in the northern coalfield of England, at Elswick and Pelton collieries, the outlet of the drum is provided with a shifting lip, in order that the area of the aperture through which the discharge takes place may be increased or diminished according to the speed of the arms. Another improvement consists in the use of a tapering chimney with an increasing section, in order to diminish gradually the velocity of the air leaving the fan before it reaches the external atmosphere, whereby a considerably increased pressure is made available, which, under ordinary circumstances, is lost when the air is thrown out at the circumference at an unnecessarily high speed. The construction of the fan offers no special peculiarities. Six arms are usually employed; but for the largest size it is proposed to increase the number to eight; the diameter varies from 22 to 30 feet, and the breadth of the arms from 7 to 13 feet. The amount of air drawn per minute is about 105,000 cubic feet, at a pressure varying from 1½ to 3½ inches of water.

Such are the means which have been adopted to urge currents of air, with rapidity sufficient to sweep from all the passages of the mines any accumulations of fire-damp. Yet, notwithstanding all the attention which has been given to this matter, we are constantly hearing of the most disastrous explosions. Nearly all of these may, however, be referred to carelessness—sometimes so gross as to amount to wilfulness—on the part of the colliers. Naked lights may be forbidden, safety-lamps may be locked, and all possible care taken to secure the proper amount of ventilation. After all, a man or a boy leaves a door open, and thus deranges the current of air. Men, though forbidden, will smoke; and the fact of finding lucifer-matches in the pockets of men who have been killed, tells us how reckless a man the collier is.

Professor Phillips, in his "Report on Colliery Explosions," has the following remarks:—

"Abundant currents of air may be so misdirected as to yield bad ventilation; the safety-lamp may be so unwisely handled as to endanger the lives it should protect; the best regulations may, if not strictly carried out, become sources of mischief. The general remedies for these errors, or crimes, are instruction and responsibility; increased knowledge, and stronger motives to use it rightly —knowledge is nowhere more powerful, obedience nowhere more necessary, than in a coal-mine."

Until the young miners are instructed in the necessity of observing, with all strictness, the rules which superior knowledge has proved to be essential to their safety, we cannot hope to prevent those calamities, which we so much bewail.

A larger number of miners perish from the effects of the "after-damp," or "choke-damp"—carbonic acid—than from the actual explosion of fire-damp. When the mixture of carburetted hydrogen and air is exploded, the carbon combines with oxygen to form carbonic acid, and the levels become filled with this deadly vapour. Carbonic acid kills by asphyxia: the action of the heart ceasing with the inhalation of irrespirable gases. Now, could those who were rendered insensible by the after-damp be speedily removed to pure air, they might be, by a little careful attention, restored to animation. It therefore becomes of the first importance to have at hand the means which would enable men to penetrate the dangerous gases and rescue their comrades. The most simple method is to place in a coarse bag a mixture of powdered Glauber salts—the sulphate of soda—and lime. This tied over the nose and mouth, effectually absorbs the carbonic acid, and prevents its exercising any injurious effect on respiration.

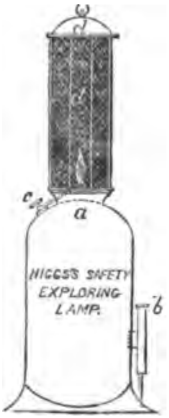
Many plans have been devised for enabling men to penetrate dangerous gases. One was by a well-known colliery-viewer of Newcastle, Mr. T. Y. Hall, which partook of a permanent character. Safety-pipes of any satisfactory material were to be laid down in the "thill," or floor of the main galleries of the mine, in the direction taken by the air, from the top of the "downcast" shaft into the workings, and back through the "return" to the "upcast" shaft. These pipes to be provided with boxes or joints, at intervals of about 40 or 50 yards—such is the permanent arrangement. An air-tight dress or casing is constructed, which can be so secured,—as is the diver's dress—that the man wearing it breathes only the enclosed air. Flexible tubes from the dress can be connected with the boxes or joints on the safety-pipes, and these tubes removed at will by the explorer: having advanced the 40 or 50 yards, which is the length of the flexible pipe, it is unscrewed and attached to the next joint, so that he breathes the pure air passing through them even in the midst of an atmosphere of death.

M. Galibert's respirating apparatus for enabling any one to penetrate dangerous gases, such as carbonic acid, is so much more simple that it must be briefly described—especially as it has met with the approval of the Academy of Sciences of Paris. A reservoir of air is carried on the back, fixed by means of braces and a waist-belt. This reservoir is a bag formed of an exterior envelope of linen, sufficiently strong to resist the roughness of the rocks or coal, with which it may come in contact. Upon this is laid a much finer linen cloth, each cloth being covered with repeated layers of india-rubber, which causes them to adhere very closely. The capacity of the bag may be varied; but M. Galibert usually makes it to hold 140 litres (1·760 to the pint), which will allow a man to remain for thirty-five minutes in the most deleterious gases without inconvenience. From this bag tubes extend over the shoulders; and they are provided with a nose and a mouth piece, which are properly secured. The man with this apparatus adjusted takes the air from the reservoir, and respires again into it. He breathes the same air many times over without experiencing any inconvenience. He knows when it is time for him to think of retreat, as his respirations become more frequent; but after the first warning he can remain seven or eight minutes without danger. This apparatus occupies but half-a-minute to prepare and adjust; it requires no instruction for its use; and with it any one can remain half-an-hour in the level of a mine filled with "choke-damp," and thus probably rescue many who would otherwise perish. M. Galibert states that, from experiments made with his apparatus, he finds that the quantity of air absorbed is about nine litres per minute when in repose; and in walking at the rate of six kilomètres (between three and four miles) an hour, is rather more than ten litres a minute.

We must briefly refer to another form of apparatus for penetrating inflammable and irrespirable gas in collieries, and invented by M. Rouquayrol, engineer to the Aveyron collieries in France. This apparatus consists of a reservoir, which is made of thick iron plates, capable of resisting pressures of twenty-five and forty atmospheres. The air is injected by means of very ingenious pumps, in which the pistons are fixed and the cylinders move. When charged with air, the apparatus is placed on the back like a knapsack. A kind of mechanical bellows is placed on the top of the reservoir, allowing the air, although at a very great pressure, to enter the lungs at the ordinary pressure. A little exterior valve, formed of two leaves of india-rubber, which are held together by the pressure of the atmosphere, opens itself to let out the respired air. In this apparatus the air is sometimes distributed to a particular kind of lamp at the same time as to the lungs, where an ordinary lamp or a Davy could not be used; but in this case an electric light burning in a closed tube is always the safest means of lighting. In the accompanyiug plate each of these three kinds of apparatus is represented; and for the drawings of the apparatus invented by M. Galibert, and that of M. Rouquayrol, we are indebted to 'La Vie Souterraine' of M. Simonin—a book of much interest, which we understand will be published in English by Messrs. Chapman and Hall.

Provided with this apparatus of Rouquayrol, a man can breathe with the same ease under water; some successful experiments have been made at the bottom of rivers and at the bottom of the sea. The apparatus is far preferable to the awkward and heavy apparatus which is usually worn by divers. In mines it may be used, if necessary, for working under water at the bottom of sinkings, as for repairing broken pumps.

In M. Rouquayrol's arrangements provision is made for supplying air to a lamp. A much more simple and ingenious arrangement has been invented in this country by Mr. Samuel Higgs, junior, of Penzance. The object of this invention is to provide a good and safe light in exploring the dangerous parts of coal mines, or, in cases of accident, to ensure a continuous light in searching for any unfortunate miners who may still be alive, but unable to escape without aid. The lamp consists of the best form of the Davy lamp, with a steel cylinder below it. Into this atmospheric air is condensed by an ordinary air-pump. There is a tube through which the air is admitted to the flame, within the wire-gauze, and the quantity required is regulated by a screw valve, as shown in the annexed woodcut. The weight of this lamp complete is not more than five pounds, and a good and safe light can be maintained for some time.



We call attention to these arrangements in the hope that they—or some modification of them—may be so far adopted as to be always at hand in collieries where they are working upon seams of coal known to be fiery.

It was our purpose to have remarked on the methods by which a safe and sufficient light is obtained for use in the coal-mines; and also to have examined into the value of Ansell's very ingenious Fire-damp Indicator. The question of ventilation, although popularly treated of, has, however, occupied the space which is, at present, at our disposal.

VI. BELGIAN COMPETITION IN THE IRON MANUFACTURE.

By Bernhard Samuelson, M.P.

To appreciate the capacity of a country for producing Iron, it is necessary in the first instance to ascertain its facilities for supplying fuel.

Belgium possesses extensive deposits of Coal, and an industrious population. The colliers of Belgium are content to earn on the average barely one-half the daily wages paid in this country; but owing to the great dip of the seams of coal, and to other causes, the labour of extraction is greatly in excess of that in most parts of the United Kingdom, and consequently the cost of labour *per ton* is far greater than in our coal-mines.

For instance, the average cost of ordinary labour in the pit and at the pit's mouth is, in the district of Liége, 3*s.* 2*d.* per ton, and in that of Hainault, 4*s.* 9*d.* per ton.

In three pits fairly representing the various conditions of coal-mining in the North of England, the corresponding wages, during the last six months of 1866, were, on the average,—

No. 1 Pit.	No. 2 Pit.	No. 3 Pit.
1*s.* 7*d.*	1*s.* 6¾*d.*	1*s.* 10½*d.*

The charges for propping, &c., are proportionately greater in Belgium than in this country; and the general result is, that the price of coal at the pit's mouth per ton is, at Liége 10*s.* 6*d.*; Hainault 13*s.*, against North of England pits, 5*s.* to 6*s.* 6*d.* per ton.

So onerous are the prices of fuel to the Belgian iron manufacturers, that on the 8th of January they resolved, at a meeting held at Liége, to take measures for procuring a supply from the Prussian coal-fields.

The coal-mines of Belgium—

Produced, in 1865	11,840,703	tons
Against, in 1863	10,345,330	„
Increase in two years	1,495,373	„

The coal-mines in the United Kingdom—

Produced, in 1865	98,150,000	tons
Against, in 1863	86,292,000	„
Increase in two years	11,858,000	„

Thus the average annual ratio of increase of production has been as nearly as possible the same (6½ per cent.) in each country.

But the *increase* alone on the two years in this country, is equivalent to the *entire production* of Belgium.

The production of Iron in Belgium was—

In 1865	455,035 tons
In 1861	311,838 „
Increase in four years	143,897 tons;

or about 11 per cent. per annum on 1861.

The production of Iron in the United Kingdom was

In 1865	4,819,254 tons
In 1861	3,712,390 „
	1,106,864 tons;

or about 7 per cent. per annum on 1861.

But it will be seen from the preceding figures that the average *increase alone* of the production of Iron in this country in two years is, like that of coal, in excess of the *entire production* of Belgium.

Of the 455,035 tons of Pig Iron produced in Belgium in 1865, about 370,000 tons were destined to be converted into manufactured Iron (the remainder being of a quality suitable for the foundry), and 276,277 tons of Wrought Iron were actually produced.

The wages of the Ironworkers are about equal to those of South Wales, but lower than those of any other part of the United Kingdom.

I am unable to compare this production usefully with that of the United Kingdom, as I do not consider the statistics of the production of Wrought Iron in England reliable, but it is possible to compare the *Exports* from the two countries.

Exports from Belgium of Iron and Iron-manufactures:—

	1864.	1865.	Ten months of 1866.
TOTAL . . .	180,870	136,360	87,771

Showing a gradual decline in the Export of Iron from Belgium.

Taking the Exportation of rails, bars, &c., exclusive of Pig Iron or Castings, the result is similar.

Exports from Belgium of Malleable Iron:—

	1864.	1865.	Ten months of 1866.
Tons	148,530	125,649	74,693

And it may here be remarked, with reference to a contract for 40,000 tons of rails which it was reported would be given to the Belgian works, that the greater portion, if not the whole, has been actually taken by British manufacturers.

Turning now to the Exports of Iron from the United Kingdom we have in—

	1864.	1865.	1866.
Tons	1,476,130	1,593,632	1,647.345

showing an increase on each year, including the last, notwithstanding the derangements of various kinds which affected the Iron trade in 1866. The British quantities are *exclusive* of castings, &c., which are *included* in the Belgian figures.*

It has been stated further that Belgian and French Iron is being largely used in England. The Belgian Returns show that the Export of Iron from Belgium to the United Kingdom was—

	1865.	Ten months of 1866.
Tons	14,193	1,817

and the total Export of Iron manufactured in France to *all countries* in the first eleven months of 1866, was 2,494 tons; so that it is needless to inquire what proportion of French iron came to this country.

N.B.—*The entire Export of Iron from France in the eleven months was* 37,578 *tons, but the whole of this quantity, except the above* 2,494, *consisted of foreign Iron.*

I have not been able to obtain any return of the imports of Foreign Machinery into the United Kingdom (Mr. Laird, M.P., has moved for a return of the quantities), but the *Exports* were as follows:—

DECLARED VALUE.

	1864.	1865.	1866.
Steam Engines . .	£1,617,117	£1,958,533	£1,750,492
Other sorts	£3,231,475	£3,264,100	£2,998,692

This slight falling off in 1866 is accounted for, as the detailed figures show, by an almost entire cessation of a large temporary demand for Egypt, and by a diminution of exports to Germany and Spain, arising in each case from obvious causes.

It may be useful to add, that we *exported* to Belgium in 1866 (partly, no doubt, in transit to Germany) machinery of the declared value of 151,297*l.*

It is unnecessary to offer any comment on these figures, as establishing the relative position of the iron manufacture in the two countries; but on the other hand, I would direct attention to the fact, that the exports of *machinery* to Belgium have, in the last five years, consisted chiefly of that used in spinning woollen and worsted yarns, which, coupled with this other fact, that we *imported* during the first eleven months of 1866, *woollen manufactures* valued at 1,702,569*l.*, is suggestive of competition in a branch of industry different from that to which public attention has been drawn.*

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* There is a considerable and increasing export of iron from the United Kingdom to Belgium, but it is included in the Board of Trade returns in that to "other countries," and not much information could be derived if it were published separately, inasmuch as a portion is iron *in transitu* to Germany.

VII. MANCHESTER: ITS SANITARY AND SOCIAL STATE, AND ITS CORPORATE RULERS.

By George Greaves, Consulting Medical Officer, Chorlton Union Hospital, &c.

The increased attention happily paid, during the last quarter of a century, to sanitary science, beside adding greatly to our knowledge of the subject, has led to extended and more stringent legislation in reference to it. How the authorities intrusted with the care of the Public Health have used the increased knowledge and greater powers thus placed at their disposal, was shown to some extent in an article in a recent number of this Journal. The subject was, however, by no means exhausted; and it is one of such transcendent importance, that no apology can be necessary for recurring to it, unpleasant, and derogatory to our national pride as it is. In the ensuing remarks the inquiry will be limited to Manchester, because it is believed that, whatever be the shortcomings of the civic rulers of other places, nowhere are the laws of health more systematically violated than in Manchester by those whose special duty it is to obey them.

The metropolis of the manufacturing district has for years disputed with its chief seaport the bad distinction of being the most unhealthy town in Great Britain. In some recent weeks its death-rate has been higher than that of Liverpool. As the rate has been calculated for the whole city, including suburban districts almost as favourably circumstanced for health as many small country-towns, the mortality in other districts must necessarily be enormous. It has, in fact, recently been shown that in some of them the deaths have occasionally exceeded the births.

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* The comparative statements relating to the manufacture of iron in this country and in Belgium, are founded chiefly on statistics recorded in the Trade returns of the two countries, in the reports of our legation at Brussels, and the publications and archives of the Keeper of Mining Records, supplemented, in a few instances, by information obtained from authentic private sources. To Mr. Robert Hunt, F.R.S., the Keeper of the Records referred to, and to the other gentlemen to whom I am indebted for assistance, my obligation is cordially acknowledged. 1,000 kilogrammes have been taken by me as being equal to a ton.

To what is this excessive mortality due? Not certainly to natural causes. The climate is equal to that of any north-western town. There is a good deal of rain, but this washes the streets, flushes the sewers, and sinks rapidly into the subsoil, which is chiefly sand or gravel, or new red sandstone. Although some portions of the surface are flat, there is sufficient elevation to allow of drainage.

Manchester is also plentifully supplied with water. It stands at the junction, with the Irwell, of the Irk and Medlock, and there are several minor streams which run either into one of these or direct into the Irwell. There is also an abundance of springs. But the rivers and brooks have for many years been mere sewers, and the spring-water, contaminated as it is, by a cause presently to be referred to, with putrescent organic matter, has long since ceased to be fit for use.

Early in the century some waterworks were established in this immediate neighbourhood, but, with the increase of population, the supply thus furnished soon fell short of the demand, and twenty years since Manchester was, in respect of its supplies of pure water, probably in as deplorable a condition as any town in Europe. In this emergency, the Corporation, under the able guidance of their engineer, Mr. Bateman, projected, and at great expense carried to completion, an extensive system of artificial lakes, to be filled by the rain-water flowing from many square miles of heathy surface on the hills dividing Lancashire from Derbyshire and Yorkshire. To the abundant supply of pure water thus furnished must, doubtless, be ascribed the almost total immunity of Manchester from the cholera in its two last visitations, as compared with the extreme prevalence and fatality of the disease in 1832 and 1849. For this magnificent boon, which has made Manchester the envy of every other town in England, the Corporation deserved our warmest thanks. Unfortunately, in carrying out the scheme, they seem to have exhausted all their sanitary zeal and energy, and have been content to live on the credit thus acquired. But the fund of reputation, although large, was not inexhaustible. It is well-nigh, if not altogether, exhausted, and if the municipal authorities wish to regain the position they once held in the estimation of their fellow-citizens and of the public at large, they must arouse themselves to renewed, and even more gigantic, exertions.

If, in spite of the possession of such natural and acquired sanitary advantages, the unhealthiness of Manchester is so great, there must be some forces at work to counteract them. What those are will now be shown. It will be proved that the Corporation have done and are doing their utmost to neutralize the benefits conferred upon us by their magnificent waterworks. They have given us pure water, but have denied us pure air.

There are two ways in which the atmosphere of a great city may be made impure. One is by the products of the combustion of coal; the other is by the emanations from decomposing organic matter. In reference to the first of these, the Corporation do not do nearly all in their power; but the smoke nuisance will never be reduced to a minimum until the public at large burn their coal in a less wasteful manner. The other nuisance exists in full force, not only unchecked by the authorities, but to a great extent created by them. If it had been wished to invent a method by which the atmosphere of a town should be as highly as possible charged with the emanations from putrescent human and animal excrement, and other organic refuse, it could not, in its offensive and deleterious character, exceed the mode of dealing with such matters in favour with the Corporation of Manchester.

The various modes of treating the nightsoil of a large town, which, in the discussions of the last few years, have been recognized as consistent with the slightest regard for decency or health, may be reduced to two; the one is the prompt removal of the *excreta*, solid and fluid, to the greatest possible distance from the houses, by means of water; the other, the retention of them for a limited time, in such a manner as to be as inoffensive and innoxious as possible, and their removal by a method equally safe and inoffensive. In other words, there are the wet and the dry systems.

The method which in Manchester has been allowed to become a time-honoured institution, is neither of these, but a foul and disgusting combination of the two, having the evils of both, and the advantages of neither. It is the MIDDEN SYSTEM.

A "midden," or "ashpit," as it is now thought more euphonious to call it, is an oblong pit sunk into the ground to the depth of some five feet, and bounded on three sides by a wall, and on the fourth side by the privy, to which it forms the receptacle; it is, in fact, strictly a cesspool, excepting that, in addition to the excrementitious matter, and all kinds of domestic refuse, it receives the ashes from the fires. The pits are open to the sky, except the part which is under the seat of the privy, and excepting also the instances in which both privy and ashpit are placed between two contiguous houses, in which case they are under the floor of an upper room. The pits are lined with brickwork, and have usually a flooring of brick or flags. In one of the side-walls is an opening, through which the ashes are introduced, and through which the pit is emptied. There is, with very few exceptions, no provision for causing the ashes to fall upon and cover the *excreta*. Consequently the two matters form separate heaps, which, as the receptacle becomes full, gradually coalesce, but never commingle, except under the spade of the nightsoil-man. The deodorizing and antiseptic properties of dry ashes are thus not availed of.

The rain, so abundant here, falling upon the ashes, is by them conducted to the feculent matter, of which the rapid decomposition is further promoted by the position of these conveniences. In an immense proportion of the smaller houses, in all, in short, of those more recently built, the ashpit is in contact with the wall of the house, and its fecal contents thus receive the heat from the house-fires; or, as in an instance recently made public, they may have the benefit of the heat from some adjacent furnace. Most of the ashpits are now drained, but the opening of the drain is not in every instance on a level with the floor of the pit, but several inches above it; and where level with the floor, it is liable to be choked by the ashes or other matters, and consequently the water often stands in the pits to the depth of several inches, or even a foot or two. As the pits are in no case water-tight, their fluid contents often percolate the wall of the house, and enter the cellar where the people keep their food, and even the ground-floor rooms in which they cook and eat their meals. What the fluid is, and what the exhalations from it, need not be said. To prevent this annoyance, the people sometimes make a hole in the outer wall of the ashpit, which allows the water to flow out into the entry behind. Another portion of the water passes through the floor, and sinks into the subsoil. No wonder, therefore, that pump-water in Manchester and the neighbourhood has long been unfit for use. The underlying strata are a reservoir of a solution, ever becoming more and more concentrated, of the compounds resulting from the decomposition of human excrementitious matter. The city stands over one vast secondary cesspool. That it will some time make its presence felt, far more even than now—that the Nemesis of the violated laws of health will one day arise in her strength, and, possibly by some new form of pestilence, sweep from the earth by thousands a people so reckless and infatuated, who that has considered the subject can doubt? Even our vaunted water-supply may fail us. The water-pipes, however strong, will not for ever withstand the perpetual action of the fluid by which they are externally bathed. They are not always full. Inward leakage from the surrounding earth may take place, and the water, which flows from the hills so pure, may then enter our houses charged with poisonous elements. That this is no imaginary danger is proved by what has sometimes occurred in London. There the gas, escaping from the mains, has made its way into the water-pipes, and a light applied to a tap has caused it to emit flame. Do such thoughts as these never trouble the repose of our rulers? or, imitating a late famous statesman, do they say, "It will last our time, *après nous* LA PESTE?"

But what becomes of the portion of the rain-water, entering the pits, which neither leaks through into the houses, sinks into the earth, nor is carried off by evaporation? It enters the sewers, and is by them conveyed to the rivers or smaller streams, the main drains of Manchester. Of these the smaller, such as the Tib, Shooter's-Brook, and the Corn-Brook, are, during the greater part of their course, arched over, and as, in common with the artificial sewers, these natural ones are never* flushed except by the rain, and as none of either class is ventilated, the gases generated in them frequently enter the houses, unless there be most careful trapping. The consequence of this was recently very forcibly shown. A portion of the Corn-Brook, about a quarter of a mile in length, had, until last summer, remained open. It was covered in, and in the course of a few weeks several cases of typhoid fever, and some of obstinate diarrhœa, appeared in the neighbouring houses.

The rivers, beside the fluid drained from the ashpits, receive the sewage from the comparatively few water-closets, and from the public urinals, as well as from the slaughterhouses, pigsties, and manufactories of all kinds, including the gasworks. Of the compound thus formed no description will convey an accurate conception. It must be seen and smelt. And were it rapidly carried off the evil might be less. But it is not; the movement of the water, always necessarily slow, from the winding course of the streams, is still further impeded by weirs, which cause the more bulky solid portions of the sewage to be deposited.

And now what becomes of the solid contents of the middens? In the middle of every night gangs of men, each provided with a cart and a wheelbarrow, turn out, and before morning empty a certain number of the pits. This work is done at irregular times, and apparently with very little system. Much depends on the rate at which the pits become full, much on the urgency and frequency of the messages to the nightsoil department, something also on the social position of the individual householders, and their ability to make their complaints of inattention heard, or, it is even said, their willingness to "tip" the nightsoil men.

As this work is done in the night-time, the people, unless they chance to be awake, are not conscious of it. But they are reminded of it in the morning. The soil is conveyed by wheelbarrows, along the passages which run between the rows of houses, into the nearest street, is there laid upon the pavement, where it undergoes a process of sorting, by which what is likely to be useful as manure is separated from the broken pots, coarser cinders, and other rubbish. The "manure" is carefully removed in carts; the "rubbish" is sometimes to be seen lying in the street in the middle of the forenoon, with, of course, much of the manure adhering to it. But even when that is removed, much that is offensive remains behind. The droppings from the wheelbarrows are visible in the entries, and the place in the street where the nightsoil has lain is discoverable by more than one sense until the next shower of rain falls, or until some tidy housekeeper, not yet habituated to Manchester usages, sends her servant, with sundry bucketfuls of water, to wash away the filthy deposit.. The servants of the Corporation never do this, nor do they in the slightest degree cleanse the pits after emptying them.

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* Until within the last few years the sewers were ventilated by grated openings in the streets; stench-traps have, however, been substituted, with, of course, the effect of driving the gases generated into the houses.

The stuff thus removed having lost, while lying in the pits, a great part of its volatile and soluble elements, has comparatively little manurial value. Some time since its depreciation had become so great that the farmers would scarcely accept it as a gift. A notable expedient was hit upon. It was to collect the offal and refuse from the various slaughterhouses, to convey it to the nightsoil depôts, and then mix it with the soil. The depôts are all within the city, and, as was said in a former article, the Corporation have purchased the neighbouring houses. They need not fear complaints from their own tenants. In one of those houses four cases of fever recently occurred. It should be added that in no instance is any attempt made, by the use of a deodorizing chemical preparation, to lessen the horrid stench produced in the process of emptying the middens, or that of manufacturing the manure. Perhaps it is feared that if the manure were inodorous the farmers would not buy it.

Another mode in which the atmosphere of Manchester is made impure is due to the uncleanly habits of some of the people. In some of the worst districts it is too common to find the conveniences themselves, and the ground near them, defiled by deposits of feculent matter. Nor ought the people to be very much blamed for this. By the midden system they have been untaught the rules of cleanliness and modesty which nature teaches. Permitted, as they have been, to grow up in the midst of all that is abominable, they have learnt to tolerate it. A further excuse for the uncleanly practices of these poor people is that they are often forced into them by the want of the means of being cleanly. In a court containing fifty or seventy inhabitants, it is usual to find only two conveniences, and sometimes one, or even both of those, has been found in so ruinous a condition as to be unfit for use. In one of a series of reports made last May by the medical officers of the Chorlton Union, on the sanitary state of their respective districts, this statement appears:—

"In an area of 3,000 square yards in No. 3 District, Hulme, stand 106 habitations; of these 33 are cellar-dwellings, of which nine consist of only one room. The rest have two. In the 106 dwellings there are 154 families, consisting of 546 individuals. For that number of persons there are 26 privies but of these six only are fit for use, one to every 91 individuals." We cannot wonder that, as the report adds, "The streets are generally in a filthy condition, being swept only once a week."

There being in Manchester 50,000 ashpits, the foul emanations from them more or less pervade the whole city; but they are, of course, most abundant in such districts as that just described. In those districts, also, they are made more deleterious by the construction and arrangement of the dwellings of the people. These are such as almost entirely to prevent the dilution and removal, by the winds of heaven, of the noxious effluvia, and to retain them, in their most concentrated form, in and around the houses. Allusion has already been made to cellar dwellings. Of these there were, in 1860, 4,467 inhabited by 17,478 persons. The number has probably since been rather reduced, but with the effect of still more overcrowding those which remain. Next are the back-to-back houses. These are tenements consisting usually of two rooms, having the door and windows on one side, and therefore not allowing through-currents of air. In the rear of each such abode is another, similarly constructed, and hence the name. Of such houses as these, there are thousands in Manchester. The erection of any more of them is forbidden by a local act. But the law is evaded. Many houses, previously having rooms to the back and front, have, within the last few years, been converted into back-to-back tenements.

These abodes are further made worse by their position. An immense proportion, if not all, of the back-to-back houses stand in courts, having only one entrance, placed usually at one end, but sometimes at the side. Each court has its ashpit, with one or two public conveniences, situated usually at the end opposite to the entrance. An instance can, however, be shown in the township of Hulme, in which an ashpit stands on each side of the entrance into a court containing about a dozen houses. Every breath of air, therefore, which enters the court in a horizontal direction, comes poisoned with the effluvia from the ashpits. Such places as these are veritable stench-traps, with an inverted action. And they are fever-traps also. In the particular court just described, a number of cases of fever occurred in the course of last winter. Such was the intensity of the poison, that one young woman having, after her recovery in the union hospital, gone back to the same house, took the disease a second, and a *third* time, and after all recovered; perhaps an unique instance. In another court in the same neighbourhood, thirteen cases of fever occurred in one house. In another house, having its back entrance into the same court, were, last autumn, four fatal cases of cholera, almost the only genuine cases which occurred in Hulme.

Each court usually contains from eight to a dozen houses. But instances are to be found in which a court contains only one house. Such a court in Chorlton-upon-Medlock has lately been described by the writer, in the following terms:—

"It is a back-to-back cottage, having no window or door at the back, but a side window overlooking the Medlock. It stands in a court ten feet square. The house itself forms one side of the court, opposite to it is a slaughter-house, on the right is the back of the next house, with the narrow entrance from the street, and on the left is a dead wall, under which is placed a privy and ash-pit. Behind the wall flows, or rather stagnates, the Medlock. The flagged floor of the court, which is nearly a foot below the level of the street, is broken and uneven, and shows signs of imperfect drainage. The house consists of three rooms, each ten feet square, and nine in height, and is very dirty."

That in such a cabin, placed in such a well, with such surroundings, ashpit, slaughterhouse, and an open sewer like the Medlock, fever made its appearance, can surprise no one. The whole of the family, consisting of nine persons, had it in succession.

In reference to the homes of the people, some painfully interesting information has lately been published by the Manchester Statistical Society. It is contained in the report of a sub-committee appointed in 1865, to inquire into the social condition of two districts, not by any means the worst in Manchester.

A portion of the information given as to one of these districts, may thus be summarized. First, as to the density of the population. The area of the district being 57,000 square yards, and the population 3,316, there were about 177,403 to the square mile. The number of inhabited houses was 607, 68 of which had cellars let out as separate tenements. The number of families was 789, occupying 1,805 rooms, an average of 2·29 rooms to each family. But 151 of these families, consisting each of five, six, and even seven persons, were found to be living each only in one room. The houses are described as being very dirty. Of the 607 houses 398 are back-to-back tenements, having therefore no ventilation. Many of the privies are said to be very much exposed, and the stench from them to be a great nuisance. In one case twelve families have to make use of one privy, "*and that is closed every evening at ten o'clock by the person who keeps the key.*" Dogs are kept in great numbers. Ponies and donkeys were found in the very houses. One man had two small horses in his kitchen; another a pony and a pig in his scullery, and rabbits and dogs in other parts of the house. In one of the courts there were five donkeys kept. The state of the houses as to uncleanliness may be imagined. "Indeed," says the report, "very many of the habitations in this district are in such a condition, partly from the filthiness of the inhabitants, and partly from the smell of privies, drains, and animals, and the dampness of the walls, and, in some cases, the ruinous condition of the buildings, as to be almost intolerable and wholly unfit for human dwellings. In some cases the smells were so bad, that the visitor could not remain in the house, and was forced to call the people out, to obtain the desired information. Some of the houses have almost fallen down, and the inhabitants pay no rent. The state of the gutters and drains is, in some of the streets, very unsatisfactory."

As to the appearance of the people; out of the 789 families, 118 are described as "dirty and untidy;" and 168 as "very filthy indeed." The children and even the women were almost naked. In several instances the children were entirely so, and "eating their food out of a pan in the middle of the floor like so many pigs."

And yet a very large proportion of these people were found to be in the receipt of incomes, which, properly husbanded, would enable them to live in comfort. But most of the money goes to the public house.

Do not such facts as these, added to others which have lately been made known in reference to the want of education, justify the assertion that if there be a condition which can be described as one of retrograde civilization, it is that of a large number of the inhabitants of Manchester?

To return, however, to their sanitary condition. It has been abundantly proved, both that the sources of atmospheric contamination exist to an enormous extent, and that the existing arrangements of the buildings in large portions of the city are such as to retain the noxious exhalations in and around the habitations of the people, to infect their food, their drink, and their clothing, and to be inspired with every breath they draw. No wonder that the diseases, chronic and acute, produced by a poisoned atmosphere, are so rife, that the mortality, especially of the younger children, is so enormous, and moreover that almost all the cases of continued fever have occurred in those neighbourhoods. If cholera has lately been absent, it has been because, to the curse of foul air, that of impure water has not been added. Diarrhœa, during the last autumn was exceedingly prevalent, but it was almost entirely limited to districts such as have just been described.

One very interesting and important fact in reference to the type of fever which has recently prevailed in Manchester ought not to be omitted. Although well-marked instances of pure Typhus have not been wanting, as well as of pure Enteric or Typhoid Fever, a large proportion of the cases have been a mixture of the two, the characteristic signs of one or the other predominating in different cases.

This hybrid character of the disease is easily explicable by its double mode of causation. The effluvia from living human bodies, when concentrated, and those also probably from recent excrement, generate Typhus, while Typhoid fever is produced by the emanations from decomposing animal matters. It has been shown that in the fever-haunts of Manchester, both these causes are in operation.

It has thus been shown how the Corporation of Manchester have performed the duty of removing the predisposing causes of disease. Let us now see what they have done in the actual presence of disease, fostered by their own negligence. During the last three years, continued fever has been epidemic in Manchester, and although during the winter just passed away, it has not been quite so prevalent as in the previous one, yet for many weeks in succession, the weekly average of new cases under public treatment has not been less than eighty, to which must be added nearly as many more met with in private practice.*

It might, therefore, have been expected that the municipal authorities would be on the alert, especially since their acquisition of increased powers and greater responsibilities under the Sanitary Act of 1866. How have they acted in these altered circumstances? Let one instance answer the question.

Early in December last, fever broke out in a house situated in Riga Street, a short and rather narrow street in the older part of Hulme. The whole family, consisting of six persons, were removed to the Chorlton Union hospital. Three days after the removal of the last of them, the house was visited by the writer of this article. He found the house closely shut up, and there was no evidence of any attempt to cleanse or disinfect it. It was excessively dirty, the floors and walls almost black with filth. The only furniture to be seen was an old straw palliasse, and a quantity of cotton flocks, lying loose in a corner of one of the two bed-rooms. The remainder of the furniture had been taken under a distraint for rent, *after the fever had made its appearance in the house.* It had, of course, been taken to a broker's shop, and the various articles, impregnated as they were with the poison of typhus, had most probably been sold, and the infection thus spread abroad through the city. Three days later, the house was in the same unpurified state, excepting that the windows had, at the suggestion of the writer, been left open. These facts were reported to the Chorlton guardians, at their meeting on January 4th, and a copy of the report was ordered to be sent to the Town Clerk of Manchester. On Monday, the 7th, an inspector visited the house, and instructed the owner, or his agent, to have the house cleansed and disinfected before admitting fresh tenants. Nothing was done until the 10th, when two men set to work, and by the afternoon of the next day, had lime-washed the ceilings and the walls of the two upper rooms.

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* From the weekly returns of the Sanitary Association, it appears that in the eight weeks ending February 23rd of this year, 660 new cases of fever occurred in public practice in Manchester and Salford, an average of 83 per week. In the same period in 1866 the number was 1049, or 131 weekly. The deaths in the two periods respectively were 137 and 200. The people of the two towns were therefore, in the first two months of the present year, dying at the rate of nearly 900 per annum of a disease which ought not to exist, and those who so died were the most valuable members of society.

By that time, also, some fresh tenants had arrived. A very respectable-looking woman, with four little children, was found sitting, with a look of dismay, in the midst of a quantity of very good and clean furniture, bed-stocks, bedding, &c., which she had brought ten miles out of the country, and which was lying on the filthy floor of the sitting-room, and resting against the infected wall-paper. The palliasse found in the house when first visited had disappeared. It had probably been taken away, and sold for what it would fetch. The cotton-flocks on which some of the fever-stricken family had lain until their removal to the hospital, being unsaleable, had, without any attempt at disinfection, been thrown into the ash-pit, common to the fever-house and several neighbouring houses. Verily, the Nuisance Authority in Manchester has solved the problem, how *not* to do it. The publication in the local newspapers of the above facts, caused a little stir among the dry bones. The discovery was made that the 22nd section of the Sanitary Act, 1866, made it the duty of the Nuisance Authority, after obtaining the certificate of a medical practitioner, to disinfect such houses, provided it was not done by their owners. The City Council furnished the different Boards of Guardians in Manchester with blank forms of such certificate, with the request that when necessary they might be filled up by their medical officers.

Any one, it appears, but those whose duty it is by Act of Parliament, may perform the functions of the Nuisance Authority in Manchester.

Those who have heard or read the speeches recently made by the advocates of the Corporation, in Manchester or elsewhere, may be inclined to think that in some of the foregoing remarks they have been unfairly dealt with. With an air of injured innocence which would be amusing if the subject were not too serious, they have gone about representing themselves as cruelly persecuted by the "Theorizing Sanitary Reformers" because they are not prepared, at the bidding of a section only of those gentlemen, to abolish the dry-closet system which has grown up in Manchester, and substitute for it that of water-closets. They thus hope to avail themselves of the dissensions among their critics as an excuse for doing nothing. But as has been shown, it is an utter perversion of language to call the system established in Manchester the dry system, and the implied state of hesitation does not exist. In the minds of our *real* rulers the question is decided. The decree has gone forth that if by any means it can be prevented, water-closets shall not be substituted for privies and ashpits. An attempt at prevention, by laying an extra rate on water-closets, was defeated by the decision of a Committee of the House of Commons so long since as 1858. The compulsory re-conversion of the comparatively few water-closets into privies, is now being attempted by an illegal tax for removing the dry ashes.

Such being the determination of the authorities, ought they not at least to endeavour to make the middens inoffensive? The modes of doing this,—of to some extent converting them into dry closets, —have been urged upon the council again and again, but with the sole effect of causing them, in some new by-laws recently published, to order that in all new houses the ashpits shall be roofed over, and their contents kept dry. But these by-laws apply only to future constructions. The fifty thousand ashpits previously existing are to be left in their pristine condition of barbarism; no change is to be made in the mode of emptying them; the manufacture of manure at the nightsoil depôts is to go on unchecked, and the depôts are to remain within the city. And if the sources of atmospheric contamination are to remain, the impediments to the removal by currents of fresh air of the polluted atmosphere are also to continue. One of the new by-laws enacts that if any building erected since June, 1865, shall be declared on competent authority to be unfit for human habitation, it shall be shut up until rendered fit. None of the thousands of houses erected before that date, which are unfit for human habitation, are to be closed; nor are the confined courts in which they stand to be opened to the winds of heaven. The new by-laws will therefore have as much effect on the monster nuisance of Manchester as a teacupful of water on a raging conflagration.

VIII. THE ARTIZANS' AND LABOURERS' DWELLINGS BILL.*

All sections of the governing body of the state, with the exception of a few gentlemen who can hardly be said to belong to the present generation, are agreed upon the necessity of extending the elective franchise to a vast number of artizans and labourers from whom it has hitherto been withheld; and concurrently with this national action, all possible means are being taken by the representatives of the people to prepare the future electors for their privileges, by raising their mental intelligence, as well as their physical condition.

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* "Artizans' and Labourers' Dwellings." A Bill to provide better Dwellings for Artizans and Labourers. Prepared and brought in by Mr. M'Cullagh Torrens, Mr. Kinnaird, and Mr. Locke. Ordered by the House of Commons to be printed, 12th February, 1867.

Two phases of legislative activity present themselves prominently to the observer of social affairs; the one (hardly yet commenced) is compulsory education, and generally the extension of education amongst the masses; the other, compulsory obedience to social and sanitary laws.

When we say that there are thousands of electors living in houses, in which it is absolutely impossible that their bodies, much less their minds, can be maintained in healthy action, and that there are tens of thousands still unenfranchised who dwell in hovels compared with which the huts in some of M. du Chaillu's Ashango villages must be palaces, we are only re-stating facts which are revealed in every page of history; and to the man of science, the most hopeful feature in the present political crisis is that the privilege of electoral power cannot fail to be accompanied by a sense of pride which will stimulate its possessors to improve their own social condition; and in one respect there is an advantage in the work of Parliamentary Reform being undertaken by the Conservatives. It is they who have always sought to withhold the franchise from the masses, because they considered them unfitted to receive it; and therefore, unless they mean to belie their first principles, and to leave it in the power of their adversaries to taunt them with insincerity, and with a desire to keep the people in a state of vassalage, they must not only raise them in the political, but also in the social, scale.

Whatever may hitherto have been the opinions of men in regard to political enfranchisement—that is to say, whether they have thought the people should be improved before they were permitted to have a voice in the government of the country, or that they should be at once allowed to vote for such representatives as they presume to have their interests at heart in a superior degree to those in whose election they have had no voice—one thing is quite certain, namely, that their social condition should be improved, and that all political and religious denominations should join earnestly and disinterestedly in the noble work of social and intellectual enfranchisement.

We must, on this great question, utter no uncertain sound.

It is *we* who are answerable for the degraded condition of those fellow-citizens whom we pronounce to be unfitted for the elective franchise. It is vain for representative bodies, local or imperial, to say that the drunkenness, uncleanliness, or poverty of the people is their own fault, and they must be made to suffer the consequences. Such statements are simply admissions of ignorance, incapacity, and unfitness for office, on the part of those who make them; and the sooner the aspirants for political power acknowledge the responsibilities and duties of their position, and follow up the admission by energetic action, the better will it be for the nation.

Mr. Torrens and his colleagues, who have introduced the Artizans' Dwellings Bill (an enactment which it is only right to say, is based upon the Liverpool Sanitary Amendment Act of 1864, framed by Mr. W. T. McGowen, formerly Liverpool Law Clerk, now Town Clerk of Bradford; Mr. Shuttleworth, Ex-Town Clerk; and Mr. James Newlands, the present Borough Engineer of Liverpool*), deserve well of the community; and there is no doubt that whatever may be the present decision of the House of Commons on the question of Parliamentary Reform, there will be no difference of opinion as to the desirability of carrying, as speedily as possible, this beneficent enactment.

The process by which the Bill proposes to improve the dwellings of the humbler classes is simple and efficacious, and the only influences which can militate against its usefulness are those which may arise where the members of Corporations are corrupt, and the officials afflicted with the same weakness, or with the desire to please and serve their patrons at any hazard. Every borough must have an officer of health; every officer of health must report to juries what houses, streets, or courts are unfit for human habitation, and how they should be dealt with; whether only structural alterations are necessary, or whether total demolition is the sole alternative. Upon such reports the jury must instruct the municipal authority to act. This they will do either by allowing the owner of the "presented" property to deal with it himself according to their instructions, or, should he be unwilling to do so, and should total demolition be necessary, they must then agree with him as to terms, and purchase the property out and out.

In addition to these powers, the Bill also authorizes loans of money at a low rate of interest by the Public Works Loan Commissioners to Corporations wishful to build dwellings for such families as are likely to be turned out by the operation of the Bill; so there will in future be no justification whatever for any local governing body, whether it be of the smallest village or of the largest overcrowded commercial or manufacturing centre, if such abominable nests and rookeries as now exist, should in future be found within its jurisdiction.

But although we have expressed the conviction that all political parties will unite in passing the Bill, we are not quite so certain that it will meet with no opposition on the part of those whom it is intended to benefit the most; and such of our readers as remember what was stated in a former number of this Journal,* namely, that the Corporation of Manchester, leagued with some neighbouring municipalities, obstructed the passage of the Sanitary Act of 1866, will not be surprised to hear that the boasted metropolis of the north is pursuing a similar course with regard to the present Bill.

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* Mr. Hugh Shimmin, of Liverpool, who had written some valuable articles on the state of the courts there, was a material witness in securing the passage of the Bill.

The objection we hear raised to it in that quarter is that it will enhance the value of dilapidated tenements, and that landlords will neglect their property in order to compel the Corporation to purchase it. For the benefit of some of our landed gentlemen, who are not supposed to penetrate the municipal secrets of our large towns, we may explain that when a wealthy Corporation like that of Manchester raises such an objection to the expenditure of money in the way described, for ameliorating the condition of its working population, it has some grounds for so doing, inasmuch as landlords —aye, rich landlords—in large towns often *do* take advantage of "Improvement Acts" to sell their property to Corporations at an exorbitant price; but in this case the sinners are likely to be poor people who own a house or two in a court, and who possess little or no influence in municipal elections. The rapacity of such people must not be encouraged, even if the alternative be that Manchester (or some other larger town) shall remain what our uninitiated readers will find it to be if they will take the trouble to peruse the article on its present condition, in another portion of this Number.†

Shame on you, men of Manchester, who have amassed your fortunes by the sweat, not of your own brows, but by that of the hardy sons of toil to whom you would now deny even decent habitations! Would that the shade of Richard Cobden could rise, that he might point the finger of scorn at his successors who deny the fresh air of heaven to those upon whom he conferred the boon of cheap bread! We have little fear of the result of such opposition; it will recoil upon the opponents of the Bill, and it is but just to the citizens of Manchester to say that, as far as we have been able to ascertain, the municipal authorities do not in this, nor in any other sanitary obstructions, represent their true feelings and desires.

But the Bill is not without drawbacks, and one of these deserves attention. We think it gives too much power over the public moneys to an almost irresponsible public official, the Medical Officer of Health. We strongly recommend the addition, in committee, of a restrictive clause similar to the 49th clause of the Sanitary Act of 1866, which enables the Home Secretary to act upon the well-founded complaints of inhabitants, and we are not sure that it would not be better in the very first instance to divide the responsibility of making presentments, for, whatever may be the theory of the Bill, in practice the mode of its execution will rest entirely with one official, who, however honest he may be himself, may not always find it easy to resist the importunity of those upon whom his material interests are dependent.

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* "The Public Health," 'Quarterly Journal of Science,' Oct. 1, 1866, p. 496, on the Sanitary Condition of Manchester.

† On "Manchester: its Sanitary and Social State, and its Corporate Rulers."

These are, however, matters to be regulated in committee, and as regards the Bill itself, we can only repeat that its passage will be, in our opinion, an event of far greater importance than that still important one, the passing of a new Reform Bill.

The latter is a measure which will only be useful in so far as it enables the newly enfranchised to appoint as their representatives men who will feel a deep interest in, and will promote, their welfare; whilst the former will in a brief space of time raise masses of degraded beings, even then unenfranchised, from the status of mere animals living and following their instincts in localities hardly to be called houses, in which, if they were compelled to live, many of the lower animals would soon become etiolated and would miserably perish. There, at present, men and women live and die herded together without any acquaintance with the decencies of civilized life, seeking refuge from the tainted atmosphere of their wretched homes in the gorgeous gin palaces that stand invitingly open to receive them, and there their children are allowed to run riot, surrounded by every condition necessary to breed thieves, vagabonds, and prostitutes.

Will this be any longer tolerated in Britain? We hope not; we look for a brighter day, not far distant, when the wealthier classes of the community will, with one accord, acknowledge their obligation to provide habitable dwellings for their poorer citizens, and so give them an opportunity of acquiring the much-needed habits of modesty, sobriety, and cleanliness, and a sense of self-respect without which no one can be considered a member of a civilized community.

CHRONICLES OF SCIENCE.

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1. AGRICULTURE.

At length, after twenty months of a disastrous experience, we can report a week of entire freedom from the Cattle Plague. During the week ending March 2nd, no case was reported at Whitehall; and it only needs three weeks' continuance of this good fortune, and (excepting our liability to the reimportation of the poison) we may hope that we shall have finally got rid of the disease. That the infection is as virulent as ever when it occurs, appears, however, in the recent experience at Islington, where Mrs. Nicholl's herd was a second time attacked. The plague first appeared here in June, 1866, ran through the sheds, and spread throughout the country: it reappeared in February of this year, again ran through the herd, but was confined within the premises by the precautions which, not possible twenty months ago, are now enforced by law.

The President of the Royal Agricultural Society did well, in his Annual Address in December last, to insist upon the need of considering the disease as a conflagration; urging upon the Government that, just as the whole machinery of fire-engines and firemen is maintained where there is no fire, to extinguish it should it arise, so the existing machinery for stamping out the Cattle Plague should be maintained in readiness to deal with it, should it again attack us. The other points to which Mr. Thompson's address referred are also of first-rate agricultural importance, including the difficulties of the labour question, the need of developing those departments of farm practice which result in the production of animal food, and the call for an improved agricultural education. On the first of these topics he declared the impossibility of carrying out the so-called co-operative system in farm practice; recommending, however, as a much more likely expedient for retaining the existing agricultural labourers, that farmers generally should adopt what is already a common practice in some counties—the plan of either letting land to their labourers, or otherwise providing them with a cow's keep. A man who can ensure regular work at fair wages, with sufficient land to keep a cow and a pig, and obtain even a moderately good cottage among the friends and neighbours whom he has known from childhood, will seldom be found willing to change his position for the crowded courts and alleys of the large towns, even by the temptation of considerably higher money wages. Add to these domestic advantages offered to married labourers a system of piecework payments, by which young men shall be remunerated according to the actual value of their services, and it is probable that the ranks of the agricultural labourer may not be so rapidly thinned as, to the great inconvenience and difficulty of the farmer, of late years, they have been. The increased supply of animal food—meat and milk—which was the next topic referred to in Mr. Thompson's address, is rapidly becoming a more important branch of English agriculture. Cattle food is being grown in larger quantity, not by the laying down of ploughed lands to permanent pasture so much as by the better cultivation of green crops on arable farms. Rotations of crops are altered to suit the demands for an increased live-stock. Two green crops are cultivated in succession, and clovers and grasses, taken in alternate husbandry, are kept down more years than one; and the smaller portion of each farm which may thus sometimes be devoted to corn-growing, yields, nevertheless, an increased quantity of grain, owing to the fertilizing effect of the larger flock of sheep or herd of cattle which is thus maintained.

An instructive paper "On the Application of Manures" was read by Dr. Voelcker before the London Farmers' Club in December, in which he argued for the immediate application of farmyard dung to the land, not on the ground that loss is incurred during fermentation in the dungheap, but because there is considerable loss of soluble substances during that process by the exposure of the dungheap to rain. The unprofitableness of the old-fashioned dungheap is alleged to be owing, not so much to evaporation, as to the washing effect of rains. There is as much actually of ammonia in the reduced mass of the rotten heap, as there was "potentially," to use Dr. Ure's phrase, in the original bulk of the fresh manure there hauled together. The recommendation to put the manure at once upon the land, even though it be autumn, and for a spring crop, is perhaps hardly safe on very light land, where the soil has less ability to retain the products of its slow decomposition. The remedy for the immense loss of fertilizing material, which takes place under the ordinary management of the dungheap, on such farms, is to adopt the plan of covered yards, where the manure is allowed to accumulate under shelter until it is carried out in the spring. Another urgent recommendation of the Professor's, in connection with the application of all kinds of manures, was to take care that they were thoroughly mixed with the soil. It is doubtless owing to the perfect distribution of their fertilizing matters through naturally fertile soils, that a good season is, on such soils, able to produce an excessive crop. And the aim should be, whether in applying bone-dust, guano, or nitrates, so to triturate, reduce, or dissolve them, that, after application, every portion of the land through which a root can penetrate shall contain its share of the application ready as the food which that root requires.

The recent publication of the agricultural statistics collected by the Board of Trade does not materially alter the conclusions, to which students of that subject had already been led as to the actual and relative areas of the different crops cultivated in Great Britain. The wheat crop in England and Wales was formerly estimated at 3,800,000 acres, it is now declared to be 3,274,000. The total corn crops of the country occupied 7,920,000 acres in 1866, against 8,437,000 at which they were estimated in 1857. And the green crops (food for cattle, &c.) are put at 2,890,000 acres, against about 3,000,000 which was the estimate ten years ago. The area returned as permanent pasture now is 10,255,000; it was formerly estimated at 10,166,000 acres.

A clever pamphlet by Mr. Heywood, of Dunham Massey, Cheshire, points out to farmers that, as the cultivators of living plants and animals, they cannot do just what they please, as they might if they were the manufacturers or manipulators of merely dead material. Living creatures follow their own natural laws, and our efforts for the promotion of their health and productiveness must be obedient to their nature. Indeed, as stated in the 'Agricultural Gazette' when reviewing Mr. Heywood's pamphlet, the keeper of a living thing must be its most humble servant if it is to prosper in his hands. The nature of the creature, not the arbitrary will of its master, must determine the treatment it receives. And the fact that animals, and even plants, are not mere machines, capable of producing a double quantity of the manufactured article from a double quantity of the raw material supplied to them, rebukes a great deal of that exuberant and urgent, and often wild advice, which is frequently addressed to practical agriculturists by the amateur. They know by long experience the limits of this kind which are imposed by nature, and against which, or over which, no man ever went uninjured. Within those limits, however, it is the part of a wise and energetic man thoroughly to cultivate the field which is his own; and thus successful high farming consists in selecting animals and plants for cultivation which have great natural powers of assimilating food, and in treating them fully up to this their precocious nature.

The new organization of Chambers of Agriculture, to which reference has been made in previous Chronicles, has gradually developed during the past quarter. Such chambers now exist in almost all parts of the country, and there is a central institution in London professing to act as a common mouthpiece for them all, through which the voice of the agricultural world may be urged upon the Home Secretary, in connection with any amendment or enactment of law that is desired. The consideration of the Turnpike Trusts, with the maintenance of roads otherwise than by the outrageously expensive toll system, is the topic selected for their first attempts to move the government of the country. There are several other agricultural topics being urged in Parliament, which are equally deserving of attention with this; and they are being taken up by individual members in the House of Commons with great ability. Thus, Professor Fawcett urges the more general enforcement of the Factory Laws, which limit the hours of labour in the case of children under a certain age, and require them to attend school during certain hours of the day. Certainly the application of these laws to the case of children employed in the field would be very difficult, chiefly owing to the immense labour of inspection which would be necessary to see that they were duly carried out; but it cannot be doubted that compulsory education would ultimately be most beneficial in the agricultural districts, as elsewhere.

The severity and impolicy of the Game Laws is another topic which has lately been urged very effectively upon the House of Commons. And these and other topics of agricultural interest will, no doubt, form the subjects of discussion before the newly constituted Chambers of Agriculture throughout the country.

It will be our duty, in July, to report the place which agriculture has occupied in the great International Exhibition at Paris. The preparations for its due representation there are on the largest scale.

2. ARCHÆOLOGY AND ETHNOLOGY.

MR. ENGELHARDT's important work, entitled 'Denmark in the Early Iron Age,' forms a worthy sequel to the publications which, treating of earlier epochs, we noticed in our last Chronicle. The Iron age of Denmark has been divided by Professor Worsaae into three periods: "the Early Iron age, from about 250 to 450 A.C.; the Transition period, extending to the close of the seventh century; and the Late Iron age, terminating with the introduction of Christianity about the year 1000." The Early Iron age commences with the introduction of three very important elements of civilization, in advance of those which characterized the Bronze age immediately preceding it. These are (1) the use of Iron; (2) the employment of horses for riding and driving; and (3) the possession of an alphabet of Runic letters.

A comparison of the antiquities belonging respectively to the Bronze and Early Iron ages exhibits very remarkable contrast, of which it will be desirable to mention a few. The weapons and cutting instruments of the Early Iron age were invariably made of iron, and present a high degree of finish: instead of the cast bronze swords of the previous period we now have to deal with damascened and welded swords of iron. Bronze, or more properly brass, was, however, in use; but zinc was mixed with the copper instead of tin. The use of gold is common to the two periods; but silver, ivory, glass, agate, and porcelain beads appear to have made their first appearance during the Early Iron age. The ornamentation of the manufactured article differed very strikingly in the two periods: in the Bronze age it was geometrical, stiff, and monotonous; in the Early Iron age it consisted of heads and figures of animals, human figures, stars, pearls, &c., and not unfrequently of a religious device known as the fylfot. Boats of considerable size were built during this period, one found in Nydam Moss measuring seventy-seven feet in length. Roman antiquities have been found mixed up with those belonging to the inhabitants of Denmark at this period; but they rarely occur alone, and not a single Roman sepulchre has been met with.

Now, contrasting these characteristics of the two periods, it becomes an interesting question whether they lead to the inference that the transition from the Bronze to the Early Iron age was gradual: the result of an advancing civilization, and of peaceful intercourse with other nations; or whether they point to the conclusion that, at the termination of the Bronze period, Denmark was invaded by a more highly civilized people? Mr. Engelhardt discusses this question very clearly, and accepts the latter alternative. There is no connecting link between the swords of the Bronze and those of the Early Iron age; we have to do with "new ornaments as well as new materials, and a different composition and treatment of those formerly known." The artistic ornamentation does not indicate the infancy of art, and, what is remarkable, there is observable "a decline of art from its comparatively high development in the early period of the Iron age, to a much lower standard towards its conclusion, with regard to style and form, as well as to technical skill in metal-work." Then the sudden appearance of horses, already domesticated, and the equally sudden possession of an alphabet point in the same direction.

Another question now arises: Who were the invaders? Mr. Engelhardt observes, "The Romans, we know, never conquered Denmark. Their armies, assisted by their fleets, came as far as the Elbe, but never beyond it;" but we cannot find that he endeavours to come to any conclusion on the subject, or even that he raises the question. Indeed, perhaps the only passage in the book bearing on it is a footnote, in which it is stated that Dr. L. Müller considers the religious symbol termed the fylfot "to have originated in Eastern Asia, from whence it spread over a great part of Europe." At present it would probably be futile to enter into any argument on this point, but as our knowledge of the antiquities of the same date in other countries becomes more extended, we ought to become prepared to grapple with a problem of so much interest.

A work, entitled 'L'Homme fossile en Europe, son Industrie, ses Mœurs, ses Œuvres d'Art,' by M. Le Hon, has just been published at Brussels; and as the subject of it is coextensive with the range of this chronicle, it ought not to be passed over without notice in these pages. At the same time, as a work of this kind necessarily partakes more or less of the nature of a compilation, a detailed analysis of it would simply be a repetition, in a great measure, of what has already been stated in this and our last Chronicle. We shall therefore select for record one or two observations of the author, which contain what seem to be expressions of original views on certain subjects; and we must state our regret that they do not in all cases bear such intrinsic marks of probability as to ensure their unquestioned acceptance. M. Le Hon very properly places the first appearance of man, according to our present knowledge, after the epoch of *Elephàs meridionalis*, the evidence of his contemporaneity with that animal being too doubtful for acceptance. In Europe he believes man to have first appeared after the diminution, to a greater or less extent, of the ice of the Glacial period, and after the contemporaneous upheaval of that continent. He seems to favour the idea that the human race migrated from Asia to the newly raised countries; but at the same time he believes man to have been very little more civilized than animals; and amongst other characteristics of our remote ancestors, he enumerates that of their *teeth*, indicating that they lived on fruits and roots; but how M. Le Hon became possessed of this astonishing idea surpasses our comprehension.

The author discusses the question whether the early cave-dwellers were cannibals. He accepts the evidence in support of an affirmative conclusion, but doubts its sufficiency; and, with much reason, he leaves the matter without coming to a decision. It will not be necessary for us to discuss the questions raised in the succeeding chapters, which contain very little that is new, but a great deal that must be useful to a student. We should observe, also, that in treating of the ages of polished stone, of bronze, and of iron (Early Iron age), the author seems to be much more at home than in discussing the earlier periods, of which his account is excessively meagre.

Mr. J. E. Lee has published in the 'Geological Magazine' for last December a translation of three reports by Dr. Oscar Fraas, "On the Pre-historic Settlements of the Reindeer Age in Southern Germany." It appears that the deepening of the spring-head and the watercourse of the Schussen brook, by the proprietor of some mills in Schussenreid, led to the discovery of gigantic horns of the reindeer, with smaller ones of all ages, as well as bones of the same animal, which had been cracked to get out the marrow. Besides the remains of the reindeer, were found those of oxen, bears, wolves, the horse, and the glutton, as well as of birds and fish. "A large proportion of the horns have been formed, in a very simple and inartificial manner, into clubs or hammers, awls (some of which have projecting ears), or into agricultural tools, and other implements of incipient industry." About 600 specimens of flint flakes were discovered, besides a number of flint cores, but "no trace of metal was found, nor the mark of anything at all approaching that of a metal tool."

As regards the age of these remains, Dr. Fraas has made observations bearing both on their relative and their absolute date. Their relative age he infers to be far greater than that of any of the Lake-dwellings, and he seems to indicate his belief of their contemporaneity with the remains of the Reindeer period, discovered in the Dordogne by MM. Lartêt and Christy. As to the absolute date which can be assigned to them, we must quote Dr. Fraas's, or rather Mr. Lee's, own words:—"But a short time since there was here the pleasant little tarn, the spring-head of the brook Schussen; 700 years ago the Premonstratensian monks built their monastery; 1,000 years still earlier a Roman road, with all its traffic, is said to have passed this way; but long before all these periods there existed here a settlement where human beings carried on all the avocations of life."

Amongst the interesting monuments of antiquity, which render the valley of the Mississippi so attractive to the student of American archæology, few have obtained more attention than the group of "sacred enclosures," or "forts," whichever they may be, near Newark, Ohio. Besides these, "scattered over the same plain, and crowning the neighbouring hills, are numerous tumuli, or mounds, evidently erected by the same people that built the larger works." In a "Description of an Ancient Sepulchral Mound, near Newark, Ohio," published in the last volume of the 'American Journal of Science,' Mr. O. C. Marsh, from whose paper we have just quoted, describes the results of an excavation into one of these mounds. In it were found several skeletons and parts of skeletons, showing in some cases that the interment had been performed with great care: with them were associated piles of charred bones, the fragments of some of which were recognizable as human; showing that the interment of some individuals was accompanied by a kind of incrematory rite. With some fragmentary remains of a child was found a string of beads, neatly made of native copper, without the aid of fire, by hammering the metal in its original state. On the same string, arranged at regular intervals, were five shell-beads, of the same diameter, but about twice as long as those of copper.

At the base of the mound was found a cist, or grave, which had been excavated in the soil before the mound itself was commenced. In it were found parts of at least eight skeletons, belonging to individuals of different ages; they had evidently been thrown in carelessly, most of them soon after death, and thus presented a striking contrast to the evidences of careful burial in the mound itself. Eleven skeletons were discovered by Mr. Marsh in such a condition as to prove that the individuals had been buried in a hurried and careless manner, and he states that "nearly all of these remains were those of women and children."

With the skeletons were found implements of flint and chert, remains of various animals, all of which are still living, and most of them still inhabiting Ohio. Two vessels of very coarse pottery were discovered; some hæmatite powder, which was probably used as paint; together with needles, spoons, a whistle, a spatula, and other objects made of bone. The manner in which the teeth were worn indicates, says Mr. Marsh, "that the mound-builders, like the ancient Egyptians, and the Danes of the Stone age, did not, in eating, use the incisive teeth for cutting, as modern nations do." We must conclude our notice of this very interesting paper by stating that the author infers the large proportion of small children represented amongst the remains to indicate "for this case a rate of infant mortality (about thirty-three per cent.) which is much higher than some have supposed ever existed among rude nations."

The 'Anthropological Review' for January contains, amongst other articles of interest, what we believe to be the most tangible account yet published of the characters and the age of the human jaw found in the Trou de la Naulette, in the Valley of the Lesse. It is contained in a summary of a paper read before the Anthropological Society of London by Mr. C. Carter Blake, who had been sent by that Society to report on the recent explorations of the Bone-caves of the Valley of the Lesse conducted by Dr. Dupont, under the auspices of the Belgian Government. As Mr. Blake's conclusions are given categorically in a very brief form, we cannot do better than record them *verbatim*, as follows:—"(1) That the deposit of stratified 'lehm' under stalagmite in the Trou de la Naulette was due to the action of slowly operating causes. (2) That the individual whose jaw was found therein was contemporary with the elephant and rhinoceros, whose remains are embedded under like conditions. (3) That some of the characters afforded by the jaw indicate a resemblance to the jaws of the Slavonic peoples of Eastern Europe, as especially exemplified in the Masures and Wends. (4) That some of the characters of the jaw from the Trou de la Naulette indicate a strong resemblance to, and exaggeration of, the characters afforded by the melanous races of men, and especially the Australian. (5) That the above characters afford a distinction between the remains found in the Trou de la Naulette and the Trou de la Frontal, which latter contained the Reindeer-period individuals, strongly resembling the Calmucks of the present day."

We hope that the detection of these various resemblances may hereafter prove to be well founded; but at present the evidence seems remarkably slight. We also look forward to some explanation of the association in one individual of characters belonging to the Masures and the Wends, with others afforded by those races which, in the euphemistic dialect of anthropologists, are considerately termed "melanous."

The uses to which the ordinary types of Flint Implements, of the larger sort, were put by the people who made them, have been, in the minds of most antiquaries, associated more or less with war or the chase, though some have sought to prove that they were used for more peaceful and bucolic purposes, such as digging roots. The smaller implements are also generally supposed to have been used as cutting or scraping instruments of some kind; but Professor Steenstrup has recently published a paper, entitled "Imod Hr. Professor Worsaae's Tvedeling af Stenalderen; et Bidrag til Forstaaélsen af Stenalderens Kultur her i Norden," in which he compares them with certain stone objects used by the Esquimaux for the purpose of sinking their hooks, &c., in fishing. This idea is, to an Englishman, not a little novel, and hard to admit; but to a Scandinavian it may be more familiar, as the figures given by Professor Steenstrup show a considerable resemblance, in form and proportions, between the objects compared. At any rate, Professor Steenstrup's reputation is such that an expression of his deliberate opinion commands an unprejudiced consideration.

3. ASTRONOMY.

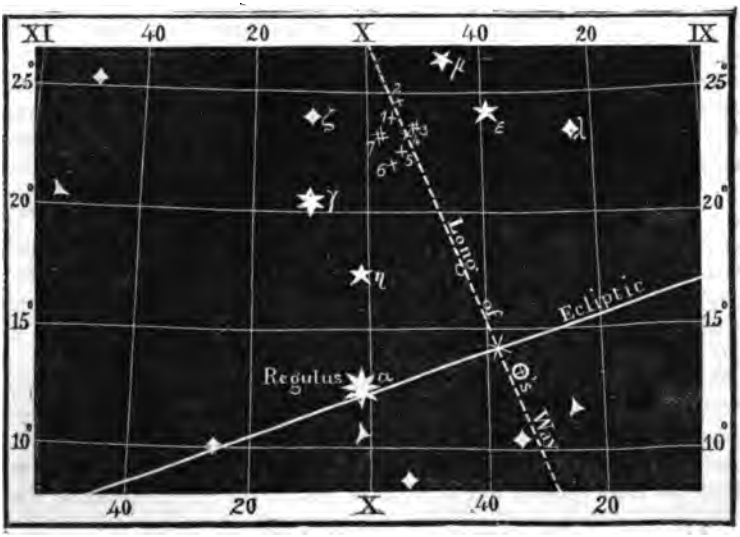
(*Including the Proceedings of the Royal Astronomical Society.*)

The gold medal of the Royal Astronomical Society has been awarded to Mr. Huggins and Dr. Miller, jointly, for their researches into the physical and chemical constitution of fixed stars, nebulæ, and comets, by means of Spectrum Analysis. Our readers, who have been presented from time to time with the results of the important investigations made by the medallists, will recognize the justice of the award.

The results of observations made by our leading astronomers upon the November meteors are now before us. In some respects they are disappointing. We cannot but feel that although the display had been predicted, it came after all somewhat as a surprise.

We miss accordingly a class of observations, which, had the shower been more confidently expected, would certainly have been suggested,—we refer to prearranged comparison-observations. If observers separated by suitable distances, had assigned themselves the task of recording the phenomena presented by the first characteristic meteor appearing after certain definite epochs, we could not have failed to have satisfactory evidence respecting the average height and velocity of the shooting stars which composed the shower. The display loses half its significance for the want of this sort of evidence. Professor Challis justly remarks on the improbability that (without some such arrangement as we have suggested) single meteors could be observed "in different localities;" he adds, with apparent regret that so favourable an opportunity was allowed to pass unused,—"it now appears to me that this class of observations is of great importance with respect to the theory of the phenomenon."

The determination of the "radiant point" of the shower was effected, however, in a most complete and satisfactory manner. It will be remembered that in Humboldt's 'Cosmos,' some doubt is expressed as to Leo being the true constellation-radiant of the November shower. The accompanying Figure will show that doubt can no longer exist on this point. It represents "the sickle" in Leo, within which group it had been announced that the radiant point might be looked for The evidence for the determination of this point was of a twofold character:—First, in the immediate neighbour-



hood of the radiant point the paths of meteors, being foreshortened, would be reduced to mere points; secondly, the paths of all the meteors produced backwards would indicate by their common intersection near a single point the existence and position of the radiant centre. Most of our best observers obtained satisfactory evidence of both sorts; all recognized the latter phenomenon. In the figure the results of nine sets of observations have been recorded:—The small cross marked (1) indicates the radiant point determined by Mr. Alexander Herschel; (2) we have deduced from the map of the Greenwich observers; (3) marks two crosses—the upper Mr. Hind's, the lower Sir J. Herschel's determination; (4) is Mr. Pritchard's; (5) Professor Grant's; (6) Professor Adams's; (7) marks two crosses—the upper Professor Challis's determination, the lower Mr. Baxendell's. Mr. Herschel quotes ten other results, some of which we have omitted, as appearing to be the results of less exact observation; others, because there was no space for them in our figure. For instance, Mr. Penrose's determination coincides almost exactly with Professor Grant's.

Mr. Maclear, who observed the shower at the Royal Observatory, Cape of Good Hope, considers that the radiant point was nearer Regulus than μ, and about η, but he did not particularly note its position.

On one point the above evidence seems decisive. The meteors, at the time of our encountering them, were neither crossing the earth's orbit from without inwards, nor from within outwards, by an appreciable angle. In the figure, the cross on the Ecliptic indicates the point on the celestial sphere towards which the earth was travelling at the moment of encounter—or, more exactly, the point towards which we in England were being carried by the combined effects of the earth's revolution and rotation. The dotted line indicates the longitude-circle through this point (which has been called the "apex of the earth's way"). Now, the fact that the radiant point lies in the neighbourhood of this point at all, shows that we *meet* the meteor-zone; the fact that the radiant-point lies about 10° to the north (along the dotted line) shows that the zone crosses the earth's orbit from the north southwards, at an angle greater than 10°,* or, as it is technically expressed, that the meteors are at their descending node, when we encounter them. If the radiant-point had lain to the left of the dotted line, the fact would have shown that the zone crossed our orbit from within outwards—that is, that the meteors were increasing their distance from the sun, while the reverse would have been shown if the radiant-point had been on the right. If we attach equal value to each of the determinations indicated in the figure, we must take as the mean position of the radiant a point not appreciably removed from the dotted line.

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* If we travel northwards against a rain-shower blown southwards, we are met more fully by the shower than if we are at rest; in other words, the shower seems to come from a point lower down towards the north: the amount of change depends on our velocity. Assuming the meteors' velocity not to differ greatly from the earth's (a probable assumption, as we shall see presently), the angle of 10° indicates a true inclination not differing greatly from 20°. Professor Newton's theory that the period of the meteors is 354 days, would make the angle about 19°.

It follows that, either the orbit in which the meteoric zone or flight travels, is nearly circular, or (which seems less probable) that the descending node of the orbit coincides (very nearly) with its aphelion or perihelion distance. Assuming an orbit very nearly circular, we must assign to the meteors a period not differing by many days from that of our own earth. To account further for the period of thirty-three years, which separates successive recurrences of maximum intensity, we must have a period either exceeding or falling short of one year by about 1-33rd part, that is, by about eleven days. If we accept Ertel's view that the three cold days in May are due to the interposition of the meteor-zone between the earth and sun, we must suppose the mean distance of the meteors from the sun to be less than the earth's mean distance, and therefore we must take the shorter period, about 354 days. All the circumstances of the zone's motion may be determined with these data, and nothing is wanting but exact observations of the velocity with which the November meteors traverse our atmosphere, to establish Professor Newton's views on a sure basis. Professor Adams has gone through the requisite calculations for obtaining the approximate elements of the orbit; but confirmatory observations are as yet wanting.

Our readers are not to understand, however, that any doubt remains respecting the planetary motions of meteors. The mere mathematical evidence afforded by their apparent motions is sufficient to establish this point on as sure a basis as that of the Copernican theory itself. All that remains in doubt is the exact form and position of the orbit described by the meteor flight around the sun.

The observations made at the Cape Town Observatory are worthy of careful examination. Briefly, they amount to this:—The display was well seen, but not quite so rich as in England; the time at which the shower reached its maximum was about 2h. 10m. A.M., Cape Mean Time, corresponding to about 1 A.M. Greenwich time; so that the display there reached its maximum about ten minutes or a quarter of an hour earlier (as to absolute time) than in England, where 1 h. 15 m. was noted as the hour of maximum intensity; at Cape Town, as in England, the period during which the display lasted (in a marked form) was about 2½ hours. To interpret these results we must form a conception of the earth as it was actually situated during the night of November 14th. An observer placed in space facing the earth, as it travelled onwards at the rate of 65,000 miles an hour would have seen its northern pole well within the darkened half-disc; England would have been brought into view before Cape Town,—England more than an hour *before*, Cape Town nearly an hour *after*, local midnight. Now, if between our observer and the advancing earth, there were situate a plane of meteors inclined 19° to the ecliptic, he would have seen the lower or southern half of the disc plunging first through the plane, the upper, or northern half, appearing last. The fact, then, that some ten minutes or a quarter of an hour elapsed between the maximum displays at Cape Town and England, is fully accounted for. The earth in that time travelled forwards some 14,000 miles, but its motion relatively to a plane inclined 19° to the ecliptic would be only one-third of this, or (roughly) about enough to shift the plane from Cape Town to England. The fact that the display was somewhat less rich at Cape Town is explained by the circumstance that the earth's surface encountered the plane less directly on the southern hemisphere, where contact first took place, than on the northern hemisphere, which was bowed down towards the plane. The fact that the display lasted nearly three hours shows that the *thickness* of the meteor zone cannot be less than 60,000 miles.

The fact that no display was seen in America does not prove, as many have supposed, that the extent of the zone is small. It follows conclusively, from the results just examined, that America was on the following (or sheltered) hemisphere of the earth during the whole time that she occupied in plunging through the meteor-zone. Therefore, the invisibility of the display in America affords additional evidence respecting the *thickness* of the zone, showing that it cannot greatly exceed the above-named estimate, but supplies no evidence whatever as to the *extent* of the zone.

From the fact that England was far advanced upon the earth's *forward* hemisphere at the epoch of maximum display, it is demonstrable that every meteor which then made its appearance above the horizon of any place in England, must have reached the earth's surface, or have been dissipated in the atmosphere,—unless we assume a height of several hundred miles for the meteors. Even this assumption, which is opposed to all evidence resulting from exact observation, would only allow the escape of a few meteors, seen low down towards the north-west. The fact that, for every meteor which grazes our atmosphere, hundreds must enter it in a direct line for the earth's surface, seems to have escaped the notice of many who have theorized on the subject. It shows that for all but the largest meteors our atmosphere acts as an efficient "buffer," deadening their impulse so thoroughly that they are vaporized by the heat equivalent to their lost velocity.

The spectrum-analysis of the November meteors appears to have been less satisfactory than that of the August meteors effected by Mr. A. Herschel. The sudden cessation of the display prevented Mr. Herschel from attending to this point as he had intended to do. Mr. Browning notes the probable appearance of a yellow line in the spectra of several meteors, and of a line of green light in the spectra of two meteors.

Herr Schmidt's observation of the disappearance of the lunar crater Linné has received the attention it deserved. It seems to be now placed beyond a doubt that a change has occurred at this point of the moon's surface. Observers have often before had occasion to suspect the occurrence of variation, but hitherto there has been no observation so satisfactory as that made by Herr Schmidt. We not only have his evidence that he has been familiar with the mountain since 1841, but the drawings of Lohrmann (1823), who described the crater as very deep. It must be explained that, for the satisfactory observation of a lunar crater, the sun must have only a small elevation at that point of the moon's surface,—in other words, we must observe the spot when near the terminator. The crater now obscured, used to become visible as a crater—that is, in shadow—when the sun's elevation was less than 5°. "*Now,*" says Schmidt, "in lower altitudes of the sun, and close on the phase, not only is a crater never visible, but there appears, in a good light, and with magnifying powers of from 300 to 600 at most, a very delicate hill of 300 toises (about 1,920 English feet) in diameter, and 5 to 6 toises (about 35 feet) in height." As a light spot Linné continues always visible; as a crater it has entirely disappeared. From views taken lately by some of our most careful observers, it would seem as if the cloud, or haze, which appears to have hung over the crater, were being now gradually dissipated. Probably, in the course of a lunation or two, we shall have more definite intelligence. It will be well to avoid speculation until observation has done its work. In the meantime, we have additional evidence, if any were needed, of the value and necessity of the lunar-mapping now in progress.

We have again to refer to the variable T Coronæ, whose sudden outbreak formed one of the most noteworthy astronomical events of the year 1866. The whole significance of this occurrence depended on the question whether it were really a sudden outbreak, or whether the star arrived at its maximum of brilliancy by a gradual process of change. Mr. Hind, therefore, did well in calling the attention of astronomers to the reported observations of Mr. Barker, of Canada, who stated that he had seen the star on the 4th of May—eight days before the observation of Mr. Baxendell; and (subsequently) that he had noted a gradual increase of brilliancy up to May 12th. Herr Schmidt, on the other hand, expressed with confidence his opinion that the star was not conspicuous at an epoch preceding only by an hour or so the time of Mr. Baxendell's observation. We ventured in our last to express agreement with Schmidt's view,—considering it highly improbable that so experienced an observer, examining the very constellation in which the strange star appeared (in the search, too, for a variable star), would have overlooked a star brighter than Alphecca, the "brilliant" of the Crown. Mr. Stone has since carefully examined Mr. Barker's claim, and, at a late meeting of the Astronomical Society, he expressed the opinion (fully supported by the evidence adduced) that "Mr. Barker's observations, previous to those of May 14th, are not entitled to the slightest credit."

Mr. J. Norman Lockyer has commenced the spectroscopic observation of sun-spots. His object is to test the rival theories of M. Faye on the one hand, and Messrs. De la Rue, Balfour Stewart, and Löewy on the other. According to M. Faye, the interior of the sun is "a nebulous gaseous mass, of feeble radiating power at a temperature of dissociation,"—a sun-spot is caused by the heating effects of an up-rush from the interior breaking through the less intensely heated photosphere. The English physicists named above refer the appearances connected with sun-spots to the cooling effects of a down-rush from the exterior. Mr. Lockyer has not yet obtained results which he can consider quite satisfactory; but, so far as he has gone, he sees confirmation of the latter view. In the spectrum of light from the spot the absorption bands were visible, as in the spectrum given by the photosphere; they appeared even to be thicker. Further, no bright lines were visible. The observation, if confirmed by the examination of larger spots, would establish the presence of descending currents, but would leave the question of greater or less heat in the neighbourhood and interior of spots undecided. Repeated observations have been afforded of the apparent descent, with diminishing brightness, of a large portion of the photosphere into the interior of a spot, but whether the change indicates a cooling process, or rather a process corresponding to the transformation of clouds into invisible vapour, is a question which observation has not yet enabled us to answer.

It is gratifying to hear that the speculum prepared by Mr. Grubb, of Dublin, for the Melbourne Observatory, is a perfect success. The telescope will, doubtless, soon be at work. Mr. Le Sueur, of Pembroke College, Cambridge (a wrangler of 1863), is entrusted with the charge of the observatory. He has been engaged in studying sidereal astronomy under Professor Adams, at the Cambridge Observatory; and we understand that Mr. Delarue has kindly undertaken to instruct him in the principles and practice of celestial photography.

In the new edition of 'Lyell's Geology' there are presented the results of Mr. Stone's calculation of the variations which have taken place in the figure and position of the earth's orbit during one million of years. These results are well worth careful study. They are sufficient to show how far from the truth is the statement so often repeated in works on popular astronomy, that the eccentricity of the orbit varies between definite limits with a definite period of oscillation, the position of the perihelion travelling (meanwhile) continually in one direction. On the contrary, the successive maxima of eccentricity differ considerably *inter se*, and so of the successive minima; the period of oscillation is variable; and the perihelion not only travels with variable velocity, but sometimes retrogrades for twenty or thirty thousand years together. We must pass over many maxima before we arrive at one approaching Le Verrier's estimate of the absolute maximum (·0777). In the whole range of years tabulated by Mr. Stone, the greatest eccentricity is 0·0747;—this was the case 850,000 years ago, and the earth's orbit was then nearly as eccentric as Mars's present orbit. The least eccentricity (within the period tabulated) occurred 900,000 years ago; at this time the eccentricity was 0·0102. The present eccentricity is 0·0168.

The late Dr. Hincks (shortly before his death) effected an elaborate calculation respecting an eclipse recorded in the 'Cuneiform Inscriptions of Western Asia.' The record runs:—"In the month Tisri the moon was eclipsed, and the moon emerged from the shadow while the sun was rising." Such an eclipse admits of identification. Accordingly, Dr. Hincks was able to satisfy himself that it occurred on September 13th, 701 B.C. (at the beginning of Sennacherib's reign). He adds:—"According to Hansen's Tables the moon would be very far—perhaps half a degree—beyond the place which would allow the phenomenon to appear, as recorded, in the latitude of Nineveh." But by adopting values given by Professor Adams, conjoined with a correction ascribed to a retardation of the earth's diurnal rotation, he considers that the circumstances of the eclipse can be satisfactorily accounted for.

PROCEEDINGS OF THE ROYAL ASTRONOMICAL SOCIETY.

Our space will not permit us to notice separately (with whatever brevity) the papers (sixteen in number) which have reference to the November star-shower. We have already summarized the results presented in them.

Messrs. De la Rue, Stewart, and Löewy present a note exhibiting the results of their second series of "Researches on Solar Physics." Their observations indicate an apparent connection between the behaviour of sun-spots and the longitude of Venus. Jupiter's influence seems also to have been detected. The planets which should exert the largest influence on the sun (assuming planetary attractions to be the true disturbing agent) are Jupiter, Venus, Saturn, and the Earth. Estimated according to their attractive effects merely, these planets should exert influences represented by the numbers 70, 9, 7, and 5 respectively. But as the influence exerted by Venus depends on the distance of the planet from the sun's equator, a large orbital inclination to this plane appears to be an important element of disturbing influence; so that the other three planets whose inclination to the sun's equator is about twice as great as that of Venus, should exhibit a disturbing power proportionately strengthened. Mercury, on the other hand, whose influence Mr. Dunkin considers should be nearly as great as that of Venus, travels nearly in the plane of the sun's equator; and further, the smallness of Mercury's mass is far from being "compensated by diminished distance."

The observers promise to give early attention to the influence of Jupiter, which should exhibit a period of six years, since the planet's sidereal period is about twelve years. In a later paper they exhibit the close agreement between the observations made at Kew, and those effected by M. Schwabe, at Dessau, during the year 1866.

The Astronomer Royal calls the attention of observers to the opportunity which will be afforded them in the present year of observing Jupiter without satellites. The phenomenon is very rare, having only been observed twice, one of the observations being that of Mr. W. R. Dawes. On August 21, Jupiter will be without satellites for one hour and three-quarters; and if the weather be favourable, all the four disappearances and the four reappearances may be observed in this country. They occur in the following order:—at 8h. 14m., G.M.T. (soon after sunset), the third satellite will enter on Jupiter's face; at 9h. 9m. the second satellite will be eclipsed in Jupiter's shadow; at 9h. 28m. the fourth; and at 10h. 4m. the first satellite will enter on Jupiter's face. All the four satellites will then be invisible. At 11h. 49m. the third satellite will pass from Jupiter's face; at 12h. 13m. the second satellite will reappear from behind the body of Jupiter; at 12h. 23m. the first, and at 13h. 54m. the fourth satellite will pass off the disk.

In a letter to Mr. Stone, Major Tennant, R.A., calls the attention of astronomers to the total eclipse of August 17, 1868. This will be visible in India; and the certainty (almost) that east of the Ghauts the weather will be fine, renders it the more desirable that such of our observers as may be in India at the time should take part in an observation of so much interest. "Probably," says Major Tennant, "the Council will not think that it would be too much to ask that the Government should, by organizing an observing party or two, give the business that element of discipline and unity of action which volunteer observers, collected from various parts of a large country, will almost necessarily want."

Mr. Peacock discusses the epoch of a partial eclipse recorded on a brass plate dug up at Calcutta, and described as having occurred "in the month Chaitra, when the sun was entering the northern hemisphere, the moon being in the Nakshatra Aswini." He identifies it with the eclipse observed at Constantinople on the 3rd of April, A.D. 889.

Mr. Wray presents an interesting paper on the correction of the secondary spectrum of object-glasses. After trying "a great number of different kinds of glass," flint and crown, having densities varying from 2·833 to 5·49, he came to the conclusion that by the mere combination of glasses, the secondary spectrum could not be corrected, "with anything like a reasonably shallow system of curves, even where four lenses were used." He finds, however that by a judicious selection of flint and crown glass, separated by an extremely thin meniscus film of highly dispersive cement, it is easy, not only to destroy the irrationality, but even to invert the spectrum. Under high powers he obtains a perfectly achromatic image of the moon and planets, "which are shown in a surprisingly sharp and clean manner on the black ground of the sky, reminding one of a first-class reflector, under its very best behaviour. The Astronomer-Royal has promised to examine a large object-glass for Mr. Wray, who has constructed one for the purpose, having a 7-inch clear aperture and a focal length of 8½ feet.

Mr. Knott exhibits in a table the apparent increase of diameter shown by star-discs as the aperture of the telescope is diminished.

Mr. Dawes remarks, with reference to the eye-piece prism suggested by him for correcting errors in double-star measurement, that in all ordinary cases he should not recommend its use; "only in those where the obliquity is such that a slight and not inconvenient inclination of the head was insufficient to bring the stars into an apparently vertical position."

The small companion of ζ Herculis having emerged from its recent conjunction with its primary, Mr. Dawes has succeeded in effecting measurement of it. One set of measures was taken *exactly at noon* on December 30th, the sky being quite unclouded. Mr. O. Struve, with the great Pulkowa refractor, found the object one of extreme difficulty, and was surprised that Mr. Dawes should have been enabled to see, much more that he should have measured the object with the smaller telescopic powers at his disposal. The measures of Mr. Dawes agree admirably with M. Struve's.

4. BOTANY, VEGETABLE MORPHOLOGY, AND PHYSIOLOGY.

ENGLAND.—*The Structure of the Seed in Solanaceæ, &c.*—Mr. Tuffen West, the well-known micrographic artist, has published a paper on this subject, read to the International Botanical Congress held in London last summer. The seeds of the *Solanaceæ* are remarkable for the rugosity of their surface, being scrobiculated, or deeply pitted. Numerous observations were made by Mr. West, under a binocular of high power, and the structure was observed by making thin slices of the objects, longitudinally and transversely, by a sharp razor. The cancellated prominences seen around each depression form sinuous intersecting bars, and are caused by the extreme thickening of the walls of the cells, owing to the deposition of solid matter upon the inner surface of the original cells. In the *Scrophulariaceæ* the structure of the seeds presents a considerable difference; but in the intermediate family, the *Atropaceæ*, formed to embrace the many genera whose corolla have an imbricated æstivation, and which have been separated by Mr. Miers from the Solanaceæ so as to render this last family uniformly consistent in the valvate æstivation of the corolla, the structure of the testa, although sufficiently distinct, approaches nearer to the character observed in *Solanaceæ* than to that of *Scrophulariaceæ*. A very large series of observations on the species of various genera of these three families is given by Mr. West.

Effect of Cold on the Growth of Trees.—Professor Caspary, of Königsberg, contributed to the proceedings of the late Botanical Congress the results of some very elaborate observations on the effect of low temperatures in altering the direction of the branches of trees, from which it appeared that different species are, in this respect, acted on in diverse manners, some moving during a frost vertically upwards, and others downward; whilst a lateral movement towards the left is nearly universal.

A Heterogeneous Flora.—At the same meeting Mr. Axel Blytt, of Christiania, read a paper "On the Vegetation of the Sogne Fiord," one of the larger arms of the sea on the coast of Norway. In this singular district, cut off from the rest of Norway by impassable mountains covered with eternal snow, and lying in lat. 61° N., all seasons and climates seem to be mingled and coexistent; whilst an Alpine flora extends down to the very sea-level, and its members grow on the rocks of the shore mixed with maritime species, vines, peaches, nectarines, and walnuts ripen their fruit in the neighbouring valleys, which are said to possess the climate of a hothouse. Mr. Blytt gives the upper limit of some of the common trees of the district, which it is interesting to compare with similar observations in this country.

The Lindley Library.—The Committee of the International Botanical Congress, in whose report the above-quoted papers and others of great value are to be found, have, after all their expenses, a residuary balance of 1,800*l.* With this they propose to purchase the Lindley Library and other books, to form the foundation of a Botanical and Horticultural Library, to be connected with the Royal Horticultural Society, provided her Majesty's Commissioners, who are interested in the advancement of the South Kensington Estate, are willing to provide a suitable reading-room, with glass cases, for the reception of such a library. The Lindley Library is largely composed of books of interest only to the student of scientific botany, and some provision should be made for making it accessible to all who would profitably use its volumes. It may very well be questioned whether a new special botanical library and reading-room is required at all—more particularly an incomplete one such as this must be, without funds to maintain it. There are other ways in which this 1,800*l.* could be made of more service to science; but then, perhaps, it would not be of so much service to the Royal Horticultural Society.

Raphides in the Lemnaceæ.—The smallest of known phanerogamous planets is not very markedly or broadly distinguished from the next species in size: that is, in other words, *Wolffia arrhiza* is in many respects similar to *Lemna minor*, and till quite recently escaped attention in this country. Dr. Henry Trimen (as we lately chronicled) has drawn attention to its occurrence, and Mr. Gulliver has now examined specimens, in order to ascertain if the microscopic structure of the tissues of the plants affords any diagnostic characters. He has ascertained that while *Wolffia arrhiza* is entirely destitute of raphides, *Lemna minor* abounds with them. This is another very encouraging proof of the value of those researches on raphidian characters at which Mr. Gulliver has so assiduously laboured.

Series of Diatomaceæ.—M. Th. Eulenstein, of Stuttgard, who is well known as one of the most active investigators of Diatomaceæ, has undertaken the publication of two distinct series of specimens of these plants. One series will consist of authentic and original specimens, and it is intended to facilitate the identification of the numerous species established by foreign authors. The uncertainty of nomenclature which has pervaded all the writings on this subject since the works of Ehrenberg and Kützing, is entirely due to a want of accurate knowledge of these specimens, which M. Eulenstein has spared no pains to obtain for the present purpose. Simultaneously with, but perfectly distinct from, this series, M. Eulenstein intends also to publish another series, which will form, as it were, a standard collection of the various types of Diatomaceæ, and will contain typical representatives of nearly all the known genera, recent and fossil. The number of collections belonging to the first mentioned series will necessarily be extremely limited; but it is to be hoped that the Royal Microscopical Society will be the depository of one of them. Those of the second series would appear to be almost indispensable for all real students of the Diatomaceæ, and we can only wish that M. Eulenstein may find his praiseworthy labour properly appreciated.

A New Arrangement of Plants.—Mr. Benjamin Clarke, F.L.S., has at length brought out a large folio work on which he has been for some years engaged. He calls it '*The* Natural System of Botany,' and it contains the results of a vast deal of labour and observation directed towards a new classification of Phanerogamous plants. The facts expressed in the various tables as regards the relative position of the ovule and its parts to the axis of the flower are no doubt valuable; and to aid him in working out this inquiry, Mr. Clarke received a grant of 10*l.* from the Royal Society. It does not appear, however, that the classification proposed is in any way a natural one,—indeed, it cannot be expected that the consideration of one group of organs alone should furnish data for such a classification. Many botanists are already acquainted with some of Mr. Clarke's observations from his papers published in the 'Ann. and Mag. Nat. Hist.,' in 1853, and in the Linnæan Society's transactions. The book is printed and published for the author, and, inasmuch as it is the work of many years of patient inquiry, he deserves the encouragement and support of his fellow-labourers.

New and Rare British Plants.—Dr. Moore, at a recent meeting of the Natural History Society of Dublin, showed specimens of *Eriophorum Alpinum*, L., which had been found growing in considerable abundance on the north margin of Gurthavabra Lake, in county Cork, by H. J. Ryder, Esq. Hitherto this plant has only been known in the British Isles from Forfar and Sutherlandshire. It grows in Lapland and Norway on low bogs and marshes, and occurs also in North America. Mr. Stewart, of Belfast, has also discovered the sweet flag *Acorus calamus*, L., in the Lurgan canal, in the north of Ireland. This plant is met with in the counties of Norfolk and Suffolk, but was supposed not to have crossed the Irish Channel at all.

Potamogeton decipiens, Nolte, has been discovered at Bath by Mrs. Hopkins, and is figured in the March number of the Journal of Botany. It is quite new to the British flora, having as yet been gathered only in Northern Germany, in Holstein, Slesvig, and the vicinity of Hamburg. It is not included in French floras. The plant comes very near to *P. lucens*, but in that species the leaves are not so much rounded at each end, are slightly stalked, and the border is thickened and minutely denticulate. The stipule is winged on the back on the lower part, and the peduncle is incrassated upwards. *P. prælongus* has leaves with a similar border to those of *P. decipiens*, but they are different in shape.

Utricularia neglecta, Lehm., has lately been ascertained as a British plant from a specimen in the British Museum, collected by the late Edward Forster, in a gravel-pit in Hainhault Forest, Essex. Professor Babington has noticed this species in all the editions of his manual, as likely to be found native in Britain, and his expectations are thus realized.

FRANCE.—*Another Botanical Congress.*—We understand that the Botanical Society of France have arranged to hold an International Botanical Congress in Paris, during the time of the Exhibition, to which botanists of all countries will be invited. The Congress will open on the 26th July, and will last for a month. Meetings will be held every Friday evening at the Society's Rooms, 84, Rue Grenelle St. Germain. On other days during the period, visits will be made to the Exhibition, to the Museum of the Jardin des Plantes, to private collections, and excursions will be made in the neighbourhood of Paris, especially towards the end of August.

Vitality of Seeds.—M. Pouchet, of Rouen, the well-known advocate of the cause of spontaneous generation, has observed that a small proportion of the seeds of *Medicago Americana* are able to withstand an uninterrupted boiling for four hours without losing their vitality. In the greater proportion of the seeds thus treated the contents had swollen and broken the integument, and the water necessarily became mucilaginous, but others successfully withstood the high temperature, the outer integument resisting the water, so that when they were sown, they sprang up in the course of from ten to twenty days.

The Histology of the Dilleniaceæ.—M. Baillon contributes a careful account of the microscopic structure of various plants of this order to the 'Comptes Rendus.' His object is to show the close relation existing between the Dilleniaceæ and the Magnoliaceæ, and in particular the striking affinities with Magnoliaceæ which the Illiceæ presents. The Dilleniaceæ are enormously rich in bundles of raphides; and in the pith of *Dillenia speciosa* these crystalline needles are exceedingly abundant. The wood of Dilleniaceæ exhibits at a certain age very remarkable fibres, with areolar punctations. They do not occur in young branches, and their gradual development presents many points of interest. The dried leaves of most Dilleniaceæ are rough to the touch, and in tropical America are used for the purpose of polishing. This property is due to the accumulation in the leaves of a very large number of concretions of a definite form, and of siliceous composition, which are insoluble in acids, excepting hydrofluoric. M. Baillon describes them minutely in *Curatella Americana*, a species which presents these siliceous accumulations on both sides of its leaves.

GERMANY.—*On the Fecundation of the Fungi.*—Professor H. Karsten has published a very valuable memoir on this subject in the 'Botanische Untersuchungen,' 1866. He had observed the fruit of a Lichen, the apothecium of *Cænogonium*, with all its spore-sacs and paraphyses, forming an hymeneal stratum, develop itself from a single cell, equivalent to a gonidial cell, and, indeed, after a previous coalescence, and apparently after the mingling of its contents with those of a branch of the cortical cells closely applied to its surface, which is furnished with porously thin spots.—The question immediately arose whether the fruit of the Discomycetes (which is in part constructed in the same way) as well as those of other allied tubular Fungi, and even those of the Hymenomycetes, were not produced in consequence of a similar process of copulation. The investigation of the development of the leafy cellular Cryptogams supports the supposition that this mode of development occurs also in the other composite fruits of the Lichens and Fungi. Professor Karsten in pursuing this question has dissected and observed the developmental history of the fruits of numerous Fungi (*Agaricus*, *Peziza*, *Helvella*), and records his observations in this paper. The following simple laws as to the multiplication of plants, results from the confirmation of his views:—

1st. The typical form of every true species of plant is propagated and maintained by sexually produced germs.

2nd. Whilst the fecundated germ-cell is developed in the Phanerogamia into a single germ, which usually rests in its envelopes for a longer or shorter period, and in the vascular Cryptogamia into one which evolves itself at once, in the cellular Cryptogamia it is developed generally into a composite fruit containing *numerous* seeds.

On Rotation and Circulation in the Cells of Plants with reference to the question of Contractility.—Professor Reichert has recently published the results of his investigations on this most interesting series of phenomena. Considered together with the invaluable observations of Professor Max Schultze on the movements of the Diatomaceæ and vegetable protoplasm, they afford a comprehensive view of the subject. Professor Reichert maintains that—

1st. In all vegetable cells with rotating, circulating, or rotato-circulating currents, two parts are to be distinguished in the contents of the cellulose capsule, namely, the central "cell-juice" or "cell-fluid," situated in the axis, and the mantle-layer, diffused between this and the cellulose capsule.

2nd. The "cell-fluid" is motionless, colourless, and non-tenacious; the "mantle-layer" consists of—first, a fluid basis, the "mantle-fluid;" secondly, the protoplasm of Hugo Mohl; and thirdly, dispersed chlorophyl corpuscles, other corpuscles, and the cell-nucleus, which is sometimes absent. The primordial utricle, if present, bounds this "mantle-layer," separating it from the cellulose capsule.

3rd. The movements in the cell result from the action of some cause or other on the fluid part of the mantle-layer, which in its movements carries the viscid "protoplasm" and the suspended particles with it. Molecular movements of minute corpuscles suspended in the "mantle-fluid" have other causes to account for them.

4th. The movements of the mantle-fluid may be recognized either by the movement of suspended granules or of separated fragments of the viscid part of the mantle-layer, as in *Chara* and *Hydrocharis*.

5th. Various modifications of the character of the movements and their direction arise from the action of the mantle-fluid on the viscid part of the mantle-layer; and by the adhesion of the viscid substance to the cellulose wall, the diversion of the current of the "fluid," and production of the viscid matter into filaments. In all cases, however, examined by Professor Reichert, he is convinced that the proximate cause of the apparent movements is the motion of this mantle-fluid, which has been hitherto overlooked; the cause of the motion of the fluid itself he will not venture to suggest. His chief point deducible from these facts is, that the viscid material is not a *contractile* protoplasm, and is not the proximate cause of the movements. Professor Schultze discovered a moving band of "protoplasm" along the raphe of Diatoms flowing from the contents of the silicious valves, which he clearly showed caused their locomotion. Professor Reichert would regard this, according to his views above noted, merely as the viscid substance set in motion by a "mantle-fluid," and not as a self-contractile protoplasm.

SWITZERLAND.—*The Nature of Anthers.*—J. Müller, the elaborator of the Euphorbiaceæ for De Candolle's 'Prodromus,' has published three brief papers in the 'Mémoires de la Société de Phys. et d'Hist. Nat. de Genève,' upon points relative to the anther which fell under his observation in the progress of his work. The first is a case in which the anther had reverted to a leaf, giving evidence that this organ is homologous with a plane lamina, its margins or line of dehiscence answering to the margins of a leaf. The second is upon the trilocular anther of *Pachystemon*, neatly showing that this (and, by just analogy, the three-celled anther of *Ayenia* also) is not a combination, but answers to a single leaf. The third exhibits the double flexure in the bud of the apex of the filament in *Cephalocroton*, the anther remaining upright, as contrasted with the inverted anthers of *Croton*.

5. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

The announcement we made in our last Chronicle of the discovery of a new metal, by MM. Meinecke and Rossler, was it seems premature. The mineral they analyzed was a specimen of phosphorite which contained a trace of copper, and the blue line they saw in the spectrum was given by this metal.

An easy and cheap mode of preparing oxygen on a large scale is a great desideratum. A method has recently* been published by Mallet, which deserves attention on this account. The inventor avails himself of the fact that cuprous chloride absorbs oxygen from the air to become converted into the oxychloride, which oxygen is driven off on the application of heat. To carry out his process the author mixes the cuprous chloride with sand or kaolin, and places it with a little water in a horizontal iron retort, where it is agitated while a current of air is made to pass. After an hour or two the formation of the oxychloride is complete; then heat is applied and the oxygen collected by suitable means. The oxychloride may afterwards be revived by a repetition of the previous treatment. A kilogramme of the cuprous chloride, it is said, will give with each operation from 28 to 30 litres of oxygen. The loss of material is very slight, 100 grammes of the chloride only losing 9 grammes in the repeated revivifications necessary to furnish 36 litres of gas.

In a similar apparatus the same agent may be used to furnish chlorine. For this purpose, hydrochloric acid gas is made to traverse the retort, by which the cuprous is converted into cupric chloride. The latter, when heated to redness, gives off half its chlorine, leaving the lower chloride to be revived as before. The author suggests this process as a means of utilizing the hydrochloric acid gas from soda furnaces.

Another process for obtaining oxygen is given by Winkler. Binoxide of manganese, when heated with sulphuric acid, yields oxygen; but the sulphate of manganese produced, forms a hard cake which is apt to cause the fracture of the retort. Winkler therefore suggests the use of bisulphate of soda in the place of sulphuric acid. A mixture of three parts of the dry bisulphate and one of manganese will answer well. The bisulphate readily fuses with the heat of a spirit-lamp, and remains liquid to the end of the operation, pure oxygen being quietly evolved.

Dragendorff furnishes us with a ready means of distinguishing between antimoniuretted and arseniuretted hydrogen. When the former, he says, is passed over fragments of caustic potash, it is decomposed, and the potash becomes covered with a brilliant coating of antimony. Arseniuretted hydrogen is not attacked by potash and passes on unchanged.

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* 'Comptes Rendus,' Feb. 4, 1867.

A paper by Stahlschmidt "On the Reducing Action of Zinc,"* shows that nitrate of potash boiled with finely-divided zinc is reduced to nitrite. The following is the process adopted:—A saturated solution of nitrate of potash is gently heated with one-tenth its volume of ammonia, and some zinc in powder. At from 30° to 40° C. the action proceeds briskly, and it may be necessary to moderate it by the application of cold. In the course of half-an-hour the nitrate is so far reduced that the addition of twice its volume of alcohol to some of the solution causes no precipitate. There will be a little free potash and some oxide of zinc in the solution. The former must be neutralized with nitric acid, and the oxide of zinc removed. The nitrate can then be separated from nitrite by crystallization.

We may say here that we have recently met with an alloy of zinc, with about 12 per cent. of iron, which is easily reduced to a fine powder, and will answer the purpose of this and other experiments of the kind.

Dr. R. Wagner† proposes to reduce the cost of the production of nitric acid, by reverting to a modification of the old process for making aqua fortis. He finds that hydrated alumina, when heated with nitrate of soda, causes the evolution of nitric, and some hyponitric acid, and forms aluminate of soda. This, when treated with carbonic acid, gives carbonate of soda; and the hydrate of alumina is reproduced for future operations. This would seem to be a useful process. Silica (fine sand for example) also decomposes nitrate of soda, even at a lower temperature than the hydrated alumina. In this instance, silicate of soda, another marketable product, is obtained.

Fichter, of Berlin, recommends the use of baryta, in preference to soda or lime, in the manufacture of pure acetic acid, from crude wood vinegar. The acetate of baryta withstands the torrefaction, necessary to get rid of the empyreumatic matters, much better than the acetates of lime or soda, and there is consequently a much smaller loss of acid.

One other technological matter deserves notice. Bolley has found that hypochlorite of magnesia bleaches much faster than the corresponding lime compound. Magnesia, he shows, is much the weaker base, and more readily parts with its chlorine. In the case of straw, he states, the hypochlorite of magnesia has a special advantage.

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* Poggendorff's 'Annalen,' 128, 466.

† Dingler's 'Polytech. Journ.,' 1 Jan. heft.

We gave in our last, a process by Dr. Wagner, for estimating the gallotannic acid in tanning materials. Another process has since been published by R. Pibram,* who exhausts the material to be examined with boiling water, filters the liquor, and precipitates with a solution of one gramme of sugar of lead in fifty grammes of water. The precipitate is collected on a weighed filter, carefully dried at 120° C., and then weighed. It may now be ignited in a porcelain crucible, and the tannin estimated by difference. This method is simple, and will probably give sufficiently accurate results for trade purposes.

We may mention here, a critical examination of some of the published processes for the estimation of Tannin, by Mr. John Watts,† who gives the preference to the process of Mittenzwey. This is an application of the well-known fact, that an alkaline solution of tannin will rapidly absorb oxygen. We must refer the reader to the original paper for a full description of the process; but as some may be employing it, we must mention a correction made by Mr. Watts. Mittenzwey states that a gramme of tannin absorbs 175 ccs. of oxygen at 20° C. Mr. Watts, however, has ascertained, by repeated experiments, that the volume of oxygen actually absorbed is 231 ccs.

The length to which our notice of the Chemical Society extends, obliges us to omit any other matters, which would otherwise have found a place.

PROCEEDINGS OF THE CHEMICAL SOCIETY.

At the meeting held on December 6, Mr. E. T. Chapman read a paper "On the Synthesis of Formic Acid." Struck by the fact that by oxidation acetate of ethyl yields two equivalents of acetic acid, Mr. Chapman came to the conclusion that nascent oxygen could not be the sole agent in effecting the change. In the case mentioned there is the same amount of hydrogen in the products obtained as in the substances operated upon. From this it would appear that either the ethyl had given up a portion of its hydrogen to the residue of the acetic acid, and then appropriated to itself two equivalents of oxygen, or that the acetic ether had been decomposed by the assimilation of water and the substitution of oxygen for hydrogen, which amounts, in fact, to the action of hydroxyl and the direct addition of hydrogen. The author believes that in most cases of oxidation of organic bodies this substitution of hydroxyl for hydrogen, or its super-addition, takes place. The synthesis of formic acid seems a direct proof of this. When finely-divided carbon (lamp-black) is boiled with permanganate of potash and sufficient sulphuric acid to liberate the permanganic acid, formic acid is produced, in very small quantity it is true, but sufficient for the author to identify and determine. Mr. Chapman took especial pains to purify the lamp-black used in the experiment, so as to preclude the possibility of any hydrogen compound being present.

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* Wittstein's 'Vierteljahrsch,' 15, 520.

† 'Pharmaceutical Journal,' March, 1867.

After this Mr. Parkinson gave an account of "Some Alloys of Magnesium, and its behaviour with non-metallic elements." The details given by the author were very long, and for a full account we must refer the reader to the 'Journal of the Chemical Society' for March, 1867. It is sufficient to say that none of the alloys of magnesium promise to be of any utility. Some of them, however, are possessed of curious properties. Bismuth, for example, with 10 per cent. of magnesium, forms an alloy which deliquesces when exposed to the air. The action of air and moisture is so great that it hisses distinctly when held in the hand. Antimony, with 10 per cent. of magnesium, behaves similarly. All the alloys are very brittle, and are easily tarnished. The one which seems the most permanent is that with zinc. The two metals must be fused together in an atmosphere of hydrogen, for when heated together in the air or under a flux the reaction is violent and explosive. The most interesting of the compounds formed with non-metallic elements is that with silicium. When silica is heated to redness with magnesium filings, silicide of magnesium is produced, which decomposes water and causes the evolution of spontaneously inflammable silicide of hydrogen.

On the same evening Mr. R. H. Smith read a paper "On the Oxidation of Ethylic Benzoate."

At the meeting on December 20, Mr. W. H. Perkin read an important paper "On the Bibasicity of Tartaric Acid." Tartaric acid has, until lately, been regarded as bibasic; but its tetratomicity being established, some chemists have found reasons for considering it tetrabasic. These conclusions have been drawn from the composition of some metallic combinations; but Mr. Perkin has studied the replaceable hydrogen in a different manner, and from the examination of new derivatives of the acid, establishes its bibasicity. We must refer the reader interested in this question to the original paper, which will be found in the 'Journal of the Chemical Society,' for March, 1867.

At the same meeting, a paper by Dr. Hunter, "On the Absorption of Vapours by Charcoal," was read. As in the author's previous experiments, cocoa-nut charcoal was employed. The vapours experimented upon were such as those of aniline, carbolic acid, aldehyde, &c., and the determinations have no immediate practical value.

Mr. Herbert M'Cleod afterwards exhibited a new continuous aspirator of his contrivance. This form of apparatus could not be made intelligible without an engraving. Its only advantage appears to be that it enables the chemist to determine with ease the amount of air aspirated.

The two foregoing papers will also be found in the March number of the Journal of the Society.

Another paper, on the same evening, was by Mr. E. T. Chapman, "On some Reactions of Hydriodic Acid." This acid, the author found, converts nitric oxide into ammonia, and decomposes nitrites, and with more difficulty nitrates of the alcohol radicals into nitric oxide, ammonia, and water, an iodide of the alcohol radical being also formed.

On January 17, a paper by Mr. T. E. Thorpe, "On the Amount of Carbonic Acid in Sea-air," was read. The author's experiments were made off Douglas, Isle of Man, and the average result of 77 observations was 3 parts of carbonic acid in 10,000 of air.

Another paper, by the same author, was "On the Amount of Carbonic Acid contained in the Atmosphere of Tropical Brazil, during the Rainy Season." At Para, during April and May, 3·28 parts of carbonic acid were found in 10,000 of air. Four parts in 10,000 was said to be the mean result for the atmosphere of Europe, away from special contaminating influences.

Dr. Frankland then read a learned paper, giving the latest results of the "Synthetical Researches on Ethers," carried on by himself in conjunction with Mr. Duppa. This second part gave an account of the action of sodium and isopropylic iodide upon ethylic acetate.

Professor Wanklyn afterwards read a paper "On the Titration of Compound Ethers." An elementary analysis, the author found to be a poor guarantee of the purity of a compound. He therefore resorted to a titration, which he finds rapid, easy, and accurate. He digests known amounts of the ether and alcoholic potash in a water-bath, and when the decomposition is terminated, which is known by the complete disappearance of the smell of the ether, the residual potash is determined by means of a standard sulphuric acid.

A paper by Mr. E. T. Chapman and Mr. M. H. Smith, "On Quantitative Anaylsis by limited Oxidation," was also read. The authors have oxidized lactic and diethoxalic acids by means of chromic acid, and determined the amounts of the resulting products. Such a mode of analysis they believe to be applicable to most organic compounds, and would show not merely the total amount of carbon, but also the forms in which it existed in the compound examined.

The last paper of the evening was by Dr. Stenhouse, "On the Preparation of Berberine from Coscinium Fenestratum, commercially known as Colombo-wood." The author exhausts the wood with a boiling solution of subacetate of lead. Part of the berberine separates on cooling, and the rest is precipitated on the addition of nitric acid. The nitrate may be decomposed by lime or ammonia, and the alkaloid purified. The same process is applicable for the extraction of theine from tea.

At the meeting on the 7th of February a note by Dr. Stenhouse, "On some Varieties of Orchella Weed, and Products obtained therefrom," was read. The author described the mode of obtaining orcin and erythrite from Rocella tinctoria; for details of which, and also of a mode of determining the amount of colour-yielding principles of lichens by the use of a standard solution of hypochlorite of sodium, we must wait the publication of the paper.

A note by Dr. Phipson, "On the Eggs of Corixa Mercenaria," was also read. These eggs deposited on reeds in fresh-water lakes in Mexico, by a kind of boat-fly, are ground by the natives and used as food. They are chemically composed of chitine with a little phosphate and carbonate of lime. Chitine, Dr. Phipson believes to be a glucoside. The eggs are supposed to contribute to the formation of a new oolitic limestone at the bottom of the Mexican lakes.

After this, Dr. Matthiesen gave an interesting lecture "On Alloys." We need only say here that the author disputes the notion that alloys are definite chemical compounds (except indeed in one or two instances), and only regards them as intimate mixtures of the metals. In some cases, however, in which the physical properties of one metal are entirely changed by a small admixture of another, the resulting alloys, it was said, could only be regarded as solidified solutions of allotropic modifications of the metals in each other. This view of the author was more fully developed in his Report to the British Association, 1863.

The last meeting we can notice was held on March 1, on which occasion Mr. E. T. Chapman read a paper "On Limited Oxidation: the Determination of the Oxygen Consumed." Referring the reader to the paper before noticed, we may say that a known quantity of the chromic acid solution is titrated with oxalic acid, and the resulting carbonic acid weighed. Another quantity of the chromic solution is then digested with the organic body, as previously described, and after digestion the solution is titrated in the same manner with oxalic acid. The difference in the amount of carbonic acid obtained, is the measure of the oxygen consumed. This method was specially recommended for the estimation of alcohol, and generally as a proved method in a great variety of quantitative examinations.

6. ENGINEERING—CIVIL AND MECHANICAL.

The winter season is not generally the busiest time amongst members of the engineering profession; works already commenced are, of course, not permitted to remain at a standstill, but few new works are commenced until the spring. Mechanical engineers generally are now beginning to get more busy, after rather a long period of stagnation; locomotive engineers especially have plenty of work before them, and others are perhaps more or less occupied in connection with the forthcoming Paris Exhibition.

The bills before Parliament do not exhibit any very great activity on the part of engineers, there being only ninety-six for railways, whereof sixty-one are for new lines, few of which are of any great length; and eighty-three for miscellaneous works.

Amongst the many important railway works at present in progress, may be mentioned the Great Eastern Metropolitan Extension, and the East London Railways, between Mile End Old Town and Liverpool Street. Between these points, the two lines will follow the same course, only at different levels; the East London being below the surface of the ground, and the Great Eastern above it, thus necessitating the construction of a combined viaduct and covered way. The former line will also make use of the Thames Tunnel, and will serve a very important purpose in connecting the lines north and south of the Thames to the East of London Bridge. Four-fifths of the length of the Metropolitan and St. John's Wood line has now been completed, and it is expected that it will be opened early in the autumn of the present year. One of the bills before Parliament is for the reintroduction of omnibus railways into London; there can be no doubt that such an addition to the present means of communication would be most acceptable, but whether it will prove more successful than the similar attempt made a few years back by Mr. Train, remains to be proved. In Liverpool also, an effort, supported by the Town Council, is being made in the same direction.

The works on the Great Northern Railway, between Doncaster and Gainsborough, were expected to have been completed by the 1st March; on the opening of this line the whole of the coal traffic between Doncaster and London will pass over it *viâ* Lincoln and Peterborough. The Stonehouse and Nailsworth branch of the Midland Railway was opened in February last. The opening of the Salisbury and Dorset Railway took place on the 27th December; and the extension to connect the Neath and Brecon line with the Brecon and Merthyr system has been completed; thus opening a new route from Swansea, Llanelly, and the western districts of South Wales to North Wales, Birkenhead, Liverpool, Manchester, &c.

With reference to Railways abroad, we notice that the line over Mont Cenis is rapidly approaching completion; and it is expected that the section between Modane and Susa will be opened by May next, and that the whole will be completed by the following July. Several lines of railway in and about Paris have recently been completed, and others are in contemplation in connection with the Chemin de Fer du Ceinture. In Prussia, the construction of railways from Harburg, opposite Hamburg, to Stade and Cuxhaven, and from Nordhausen, in Central Germany, to Erfurt, have been commenced. In Russia, much has already been done, and out of 3,235 miles sanctioned, 2,570 are open to the public. There is the Trunk line of 400 miles, from St. Petersburg to Moscow; the St. Petersburg and Warsaw line of about 800 miles, with a branch to the Prussian frontier; several short branch lines from St. Petersburg, and the line from Warsaw to the Austrian frontier, about 446 miles. Southwards, there is a line from Odessa to Balta, with a branch to Tiraspol to the west. About ninety miles of line are being made in the valleys of the Volga and the Don. Lines will radiate from Moscow to Nijni Novgorod, to Serguicosk, to Riasan and Koslof. About 630 miles are being made from Orel, *viâ* Smolensk and Uitepsk, to Dunaburg, which will give those towns direct communication with the Baltic at Riga. The further extensions contemplated will complete the through communication between the Baltic provinces and the south, including the parts of the Black Sea, the Sea of Asof, and the Caspian Sea. The lines recently opened in Italy, consist of that connecting Pavia, Cremona, and Brescia; and the line between Catania and Messina. Passengers can now go from Florence to Rome in twelve hours by way of Perugia, the line between Arezzo and Foligno being now completed. The month of January last witnessed the opening of a railway section from Pasewolk to the frontier of Mecklenburg; the completion of this link is of the greatest importance to Stettin, as the Pomeranian network of lines will now be united to a vast district, comprising the whole territory of Mecklenburg, Schleswig, Lauenburg, the Hanse Towns, and a great part of Hanover. The Estramadura Railway, also recently opened, establishes an uninterrupted communication between Lisbon and St. Petersburg, by means of a line of rails 3,940 miles in length, which, starting from the north of the Tagus, terminates for the present at the confluence of the Volga and the Oka, at Nijni Novgorod, passing through Madrid, Paris, Brussels, Berlin, and Warsaw. In India, several short but important sections of railway have recently been completed. The first train ran into Delhi on the morning of the

24th October last. A sufficient number of detached portions of railway are now open to admit of the journey from Calcutta to Bombay being performed in about four days. Forty years ago the United States had but three miles of railroad in operation; but they now have 35,341 miles open, and 15,943 miles under construction. The United States Congress, in order to aid the establishment of the South Pacific Railroad, has granted that undertaking 25,000 acres of land per mile; the distance between New York and San Francisco by this route will be 3,200 miles. Advices from Brazil state that the San Paulo Railway was expected to be opened on the 1st January last; and that a prospectus has been issued of the Paraguassu Steam Tramroad Company, for the construction of a train line of 250 miles, from the city of Bahia to the city of Lençoes, near the diamond-mines, with which there is already a steady traffic.

Amongst harbour and dock works we may notice, in the first place, the extensive additions now in progress to the Government docks at Chatham, on a tract of marsh land known by the name of St. Mary's Island. For some time past the admiralty have been carrying on some very important works, with a view of reclaiming St. Mary's Island; but in addition to the mere work of reclamation, the scheme includes the construction of a series of extensive docks and workshops, all of which are estimated to cost about one-and-a-half million sterling. The Millwall Docks, now in course of construction on the Isle of Dogs, will, it is expected, be finished and open for shipping by the end of next autumn. There will be two docks,—the one of 25 acres, and the other 10½ acres in extent; the depth of water in each basin will be about 29 feet and the entrance locks will be 80 feet wide. A large graving-dock, 402 feet long by 86 feet wide, is also being constructed as an adjunct to the other works. On the 1st January the contractors commenced the great works for the extension of Portsmouth Dockyard, the estimated cost of which is 1,500,000*l.* Up to the present time Glasgow has been without any dock accommodation, or tidal basin; and although the wharfing is extended on either side of the river for a great distance, it is inadequate to the demands upon it. A tidal basin is now in course of construction there, which will be completed in a few months; and the commencement of another basin is contemplated soon after the completion of that now in progress. New works are under construction on either side of the river at Belfast; those on the County Down side consist of a large open tidal basin and a capacious graving dock; and those on the County Antrim side consist of a floating dock, 630 feet long by 225 feet wide, and a tidal dock 600 feet long by 550 wide. The entrance to the former is 60 feet, and to the tidal dock 80 feet in width. The cost of the entire works will be 150,000*l.* A new port has not long since been established in the Bristol Channel, at

Port Cawl, in Glamorganshire, which will be of immense value to the ironmasters and coal lessees of South Wales. The new works recently constructed here consist of an inner floating dock of 7½ acres, with quay walls of massive masonry. The depth of water in the entrance basin and on the sill of the dock is 29 feet, at spring tides. In addition to the docks there is also an extensive wharf frontage, high level shipping stages, and other conveniences. Active operations are in progress for constructing docks and a pier at the Cape of Good Hope; the principal basin has to be mined in rock, and the *débris* has been carried away by locomotives to the extremity of a breakwater, which has now a length of nearly 1,700 feet. The Pasha of Egypt has ordered, in France, a great iron floating-dock for service in the Port of Alexandria. Harbour works are also in contemplation at St. Helier's, Jersey. It is proposed to construct docks and warehouses, and to form a spacious harbour on the Danube, and to establish a port to the north of Elsinore, in Denmark.

Several proposals have recently been put forward, for the purpose of facilitating the means of communication across the British Channel. Amongst others, Mr. James Chalmers has introduced a modification of his well-known scheme for a railway beneath the Channel, to be conducted through a double row of iron pipes, lined with brick, and submerged. Other more probable schemes have been suggested by Mr. Fowler and Mr. Daft, for the establishment of ferry-boats which shall convey a railway train entire—passengers and all—without necessitating any change of carriages.

From the report of the Manchester Boiler Association it appears that boiler explosions are steadily increasing in number and fatality. During the year 1866 there were 73 explosions in various parts of the United Kingdom, attended with a loss of 87 lives, and with injuries to 110 others. Amongst other recent inventions for the removal of boiler scale, the most remarkable is that known as the magnetic anti-incrustator. It consists of seven small magnets made of steel wire, tapering to a point at one end, and inserted radially at the other into a brass centre; this is supported horizontally in the steam space, a few inches below the roof of the boiler near one end, by a brass stud, from which it is insulated. A copper wire connects the system of magnets with the opposite end of the boiler; a current of induced electricity is thus effected, which results in the complete detachment of scale from the boiler. A new kind of boiler, called the water-tube boiler, has lately been invented both in this country and in France; its peculiarity consists in the water being contained in tubes, amongst which the flames from the fire circulate, being very nearly the opposite to the plan formerly more generally adopted. Experiments are still being carried out, with a view to the use of petroleum as fuel; but more must yet be accomplished before it can be said to have proved successful.

It is proposed to convert all the existing 32-pounder guns in the service into 64-pounders, upon Major Palliser's principle. It is reported that the converted Sneider rifles have not given satisfaction, owing to the imperfect style of workmanship in their conversion. There have recently been extensive trials of breech-loading guns, both in Vienna and in America, with a view to obtaining the best pattern gun; and similar trials will shortly take place in this country. An English gunmaker has just contracted with the French government for the manufacture of a considerable number of the Chassepot gun, and the Whitworth Company are making upwards of 200 lathes for a private firm in Paris, who have contracted to convert a large number of French rifles upon the same system.

The Mont Cenis tunnel has, during the past year, been extended 1,139 yards, making the aggregate distance pierced 7,083 yards; the total distance remaining to be pierced is 6,493 yards.

The fresh-water canal portion of the Suez Canal is now navigable; on 11th February a vessel from Siam, containing packages for the Paris Exhibition, took that route; and on 17th February a vessel of 80 tons, from Trieste, arrived in the Red Sea, having passed through Egypt by the Suez Canal.

The first locomotive made in New South Wales was tested on 15th November last on the branch line between the Redfern Railway Station and Pyrmont. It is upwards of 70-horse power, and is to be employed on the steep inclines or zigzags on the Great Western Railway.

Very considerable works for the reclamation of land in Switzerland have been determined on in the neighbourhood of the Lakes of Morat, Neuchâtel, and Bienne. The total cost will be about 300,000*l.*, and the value of the lands will be increased 626,382*l.*; the total extent to be reclaimed amounts to nearly 50,000 acres.

Mr. James Parker, a gentleman residing near London, has lately introduced a system of working engines by mixed steam and air, which he applied to the propulsion of a small road locomotive some time ago, and more recently for propelling a small vessel on the Thames. The results of these experiments were very satisfactory, and the subject has recently attracted no little attention.

Amongst the numerous treatises which come before the public every year, none perhaps aim at higher ends, or achieve more general good than those which treat science in a popular manner, without making scientific truths too subservient to the popular tastes. In the category of such works may be included the three series of "Useful Information for Engineers," which have lately emanated from the pen of Mr. William Fairbairn. The third series of this very useful little work has but recently seen the light; it consists of a reprint of six lectures, some of which have been published and distributed in the transactions of various societies and institutions, and seven papers on various subjects compiled by Mr. Fairbairn himself. The first two lectures contain a short and concise history of the advancements made in science and art; the results arising from which have been to quadruple the productive powers of the country, and to diffuse a spirit of intelligence amongst all classes of the community. The third chapter is on "Labour: its Influences and Achievements." After pointing out the necessity of labour, on which all are dependent for their subsistence, the author divides his subject into two heads—viz., *mental* and *physical* labour, which is further subdivided into *skilled* and *unskilled* labour. The points sought to be established in this lecture are, first, that labour is inherent in man and in animals; secondly, that its use is important, and ought to be cultivated; thirdly, that its influence is powerful and effective; and lastly, that its achievements are great. The fourth lecture on "Literary and Scientific Societies" is a reprint of an address delivered at the inauguration of the Southport Athenæum. In this the advantages of literary and scientific institutions are pointed out, as well as the necessity of careful study and untiring industry, for the attainment of distinction and success. The two other lectures are on "The Thickness of the Earth's Crust," and on "Iron and its Appliances." In the latter of these, iron is followed through the different stages of its utility, and it is treated in its appliance to the steam-engine, to millwork, and to machinery; the varied forms and conditions being noticed in which it is employed for security, on the one hand, and its economical distribution for the purposes of construction, on the other.

The other papers relate to the machinery of the Paris Exhibition of 1855, and of the London Exhibition of 1862, to which are added a treatise on Iron Roofs, Researches on the Insulation of Submarine Cables (undertaken at the request of the Atlantic Telegraph Company), and Experiments to determine the effect of impact, vibratory action, and long-continued changes of loads on wrought-iron girders.

At the present time, when every one is expected to possess some knowledge on scientific subjects, papers such as those above referred to cannot become too generally known; for whilst they contain much "useful information for engineers," the absence of all unnecessary technicalities renders them suitable also for the general reader.

7. ENTOMOLOGY.

(*Including the Proceedings of the Entomological Society.*)

From investigations made by M. Felix Plateau* on the muscular force of insects, he deduces the following law:—"In the same group of insects, the force varies inversely to the weight, that is to say, that of two insects belonging to the same group, the smaller presents the greatest strength." The Phytophagous families, Donaciidæ and Crioceridæ, appear to exceed all others in traction-force. The supremacy of these insects he attributes solely to their great muscular force, which is explained partly by the large size of the posterior femora, and partly by their small weight. With regard to the leaping powers of the Orthoptera, he found that *Œdipoda grossa*, which weighs 0·646 gr., raised a mean weight of 1·064 gr., and *Œdipoda parallela*, 0·194 gr., raised a mean weight of 0·638 gr. The proportions of their relative force are, therefore, 1·647, and 3·288; another example of the above law, according to which, in the same group of insects, the lightest are comparatively the strongest. As regards flight, M. Plateau finds, also, that the mean forces of insects are still in inverse proportion to the weights; but he obtained no such high results as in the case of traction or pushing.

Allusion has already been made (*ante*, p. 111) to the discovery, by Sir John Lubbock, of a new type of centipede. An elaborate paper on the subject has since been read before the Linnean Society. The animal is only $\frac{1}{25}$th of an inch in length; has a body composed of ten segments, with only nine pairs of legs, and five-jointed antennæ bifid at the extremity and quite unlike those of other Myriapods. It was proposed to be called *Pauropus Huxleyi*. The author, who has found it in great numbers in his kitchen-garden at High Elms, was at first disposed, from its minute size, to regard it as a larva; but, having examined several hundred specimens, he had come to the conclusion that it was a mature form. In its earliest state it has three pairs of legs, and the number increases at each moult; two pairs at the first, but at each of the subsequent moults a single pair only is added. Its systematic position among the Myriapoda is a matter of doubt. Sir John went very minutely into the reasons which induced him to consider that it could not be placed in either of the two great orders of the class, and that it is not only intermediate between the Chilopods and Diplopods, but that it forms a connecting link between the Myriapoda and the other classes of the annulosa. From the view of its being the type of a distinct order, however, Professor Huxley expressed his dissent. A second species of the genus was found with the first, differing in the form of the antennæ.

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* 'Ann. and Mag. Nat. Hist.,' Feb., 1867.

M. de Marseul has recently published a new edition of his 'Catalogus Coleopterorum Europæ et confinium.' The number of species is now above 16,000; but it must be recollected that to the European area is added the shores around the Mediterranean, or, in other words, North Africa and Western Asia. By this arrangement, however, comparatively few extra European genera are introduced, almost the only ones from the tropics being *Monomma*, *Callirhipis*, *Stenochia*, *Piazomias*, *Myllocerus*, and *Arrhenodes*. *Articerus* and *Himatismus*, Australian and South African genera respectively, are also represented. The work has been got up in a very careless manner; wrong authorities are often given, and the spelling is by far too frequently faulty.

The little work by Miss Stavely, on 'British Spiders, an Introduction to the Study of the British Araneidæ,' it is admitted "lays no claim to originality; the work of Mr. Blackwall on the same subject having been most freely used." It is one of the series of books on British Natural History now in course of publication by Lovell Reeve and Co., by whom we are informed they were to be "entirely the result of original research, carried to its most advanced point." This is a little too bad. As a useful abridgement of Mr. Blackwall's 'History,' Miss Stavely's volume may be recommended; but we think it would have been improved if she had given some notices of the habitats. Many species have only been taken once, or in one locality, and this it is very important should be known to the collector, for whom the work is more especially adapted.

The last part of the 'Linnæa Entomologica,' containing upwards of 480 pages, is entirely confined to, and completes Dr. Suffrian's descriptions of, the South American Cryptocephali. The plan of devoting as large a space as possible to a paper, instead of breaking it up into fragments, as is now too often the case, is much to be commended. In the enormously increasing mass of zoological literature, could not some plan be devised by which any paper may be taken out of the volume in which it appears, in order that it may be kept or classified with others of the same character? Many small, but important, papers are now often overlooked or forgotten.

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF LONDON.

December 3.—A collection of Coleoptera from Rio Janeiro was exhibited by Mr. Janson. *Stenus major*, Muls., an insect lately found at Southend and new to Britain, was exhibited by Dr. Sharp. In reference to the explanation of the cause of mimicry in butterflies, an instance was given by Mr. Bolt, of Maranham, who, having an opportunity of watching the nest of an insectivorous bird, found that the Heliconidæ, the family imitated, were invariably rejected. In reply to an observation of Dr. Sharp's, that the fact of a bird not catching an imitating butterfly like *Leptalis*, implied a want of perception on its part, Mr. Wallace said that birds sought their prey by sight and not by smell, and that it was not to be expected that a bird would catch a thousand distasteful *Heliconias* on the chance of obtaining one *Leptalis*, such being the proportion of numbers of the two insects. A paper was read by Mr. M'Lachlan on a new genus of Hemerobiidæ (*Rapisma*), and another of Perlidæ (*Stenoperla*).

December 7.—Captain Hutton, in a communication respecting the Japan silkworm (*Bombyx Yamamai*), expressed an opinion that it was nothing more than a hybrid between *Bombyx mori* and *Bombyx Sinensis*. Prof. Westwood, in exhibiting a selection of the butterflies collected many years ago in Brazil by the late Dr. Burchell, observed that an examination of this collection, which was made over a long line of country, the locality of each specimem being carefully recorded, had almost induced him to abandon his belief in the immutability of species; but he reserved the subject for fuller details at a future meeting. The following papers were read:—By Professor Zeller, communicated by Mr. Stainton, "On the *Crambidæ* and other Families of Moths," collected by the Rev. O. P. Cambridge in Egypt and the Holy Land; by Mr. Butler, "On the genus *Hestia*, with remarks on the natural affinities of the *Danaidæ*."

January 21.—*Annual Meeting.*—The President delivered an address, after which the following officers were elected for 1867:—*President*, Sir John Lubbock, Bart., F.R.S., &c.; *Treasurer*, S. Stevens, F.L.S.; *Secretaries*, J. W. Dunning, M.A., &c., and D. Sharp, M.B.; *Librarian*, E. W. Janson. It was announced that one of the prizes offered by the council for essays on Economic Entomology had been awarded to Dr. Wallace, of Colchester, for an essay on the oak-feeding silkworm of Japan.

February 4.—Mr. Wormald exhibited a collection of insects from Shanghai, made by Mr. W. Pryer, among which was a new *Bombyx*, allied to *B. Huttoni*. Mr. Janson exhibited a collection of insects from Vancouver's Island, including a specimen of the curious genus *Plectrura*. Mr. C. A. Wilson, of Adelaide, communicated some notes on *Cerapterus Macleayi* and *Calosoma Curtisii*—the latter was now found under the dried droppings of cattle, a habitat it has chosen since the introduction of those animals. Dr. Wallace read a paper "On some Variations observed in *Bombyx Cynthia* in 1866."

February 18.—Mr. Moore gave an account of the ravages of *Tomicus monographus* in India. This destructive little beetle has caused the loss of vast quantities of ale, in some cases amounting to 50 per cent. of the stock in store, by eating its way in all directions in the wood of the casks, until at some point, at last becoming perfectly porous, the contained liquid escapes. The insect has not been found in this country, although common on the continent; but it is stated that the oak staves of which the barrels are made are imported from Sweden. The inference is, therefore, that the eggs were in the wood at the time they were being made into casks; how they escape destruction during the preliminary process of steaming seems unaccountable. The insects were known in Burmah previous to 1862, but are now found in most parts of India. No case seems to have occurred in which the ale escaped while *in transitu*. Mr. Newman exhibited an ant taken at Kinloch Rannoch, and new to Britain. It was doubtful whether it was to be referred to *Formica herculeana* or *F. pubescens*; it was stated to form single cells in the stumps of old pines. Mr. Wallace read a paper "On the Geographical Distribution and Affinities of the Eastern Pieridæ." The subject, in all its aspects, was treated in the most comprehensive manner, but the views of the author, in reference to the extent of the Indian Islands as a Zoological Region, were combated at some length by Mr. Pascoe. A paper "On the Distribution of the Lepidoptera 'in Great Britain and Ireland" was communicated by Mr. Herbert Jenner Fust. This was a long and most elaborate essay, in which the distribution of 945 species were classified according to their geographic types and the areas to which they were limited in the United Kingdom; the *Tineinæ* and one or two other groups were excluded. A paper "On the *Buprestidæ* of the island of Penang was communicated by Mr. E. W. Saunders.

8. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

The place of Admiral Fitzroy, as Corresponding Member of the Paris Academy of Science, is to be filled by Captain Richards. Mr. R. H. Major, Hon. Sec. of the Royal Geographical Society, has been appointed Keeper of the Map Department in the British Museum; a new post, for which Mr. Major has well qualified himself by his researches in Ancient Geography.

This subject of Ancient Geography has received much attention of late on the other side of the Channel. A new translation of the amended text of Strabo is being produced by MM. Amédée

Tardieu, Sub-librarian, and Thoulin, the Librarian of the Institute, who have published one volume of the work. The Geography of Ptolemæus is also being reproduced in photo-lithography, from a MS. belonging to the Vatogedi Convent on Mount Athos, which has some remarkable old maps.

In England the Palestine Exploration Fund represents what we are doing for Ancient Geography. It is intended to form a museum of objects collected. Unfortunately South Kensington has been chosen as the site, otherwise the design is a most excellent one. The objects are to be classed into Sacred, Domestic, and Political Antiquities, with Geography and Natural History, and they are to consist of sculpture, casts, models, coins, photographs, pictures, plans, maps, and collections of animal, vegetable, and mineral products. In the meantime excavations are to be carried on this year to determine the site of the Temple and Holy Sepulchre. The proceedings of the Exploration Fund lead to discussion of many points, and the production of information from many others besides those immediately employed.

The exactitude of longitudes is a matter of great importance. M. Mouchez has drawn the attention to the fact that there is a difference of 30 seconds between the longitudes of Rio Janeiro as given by different authorities. The distance of Valentia from Heart's Content in Newfoundland has been determined lately at 2h. 51m. 56·5sec. For this we are of course indebted to the telegraph. A proposition has been started in New York to extend the line which is to run across Behring Straits down the coast below the Amoor to the Chinese cities, thus to connect New York with Pekin. The Australian Governments have commenced a line northwards to the Gulf of Carpentaria, and are willing to contribute a share towards the communication with the East Indian lines, but the Indian Government are not inclined to risk anything on submarine lines without assistance from home, owing to their experience of the Red Sea route.

The Leichhardt expedition has met with many repulses—it lost its leader, it has suffered great privations; but it is said that the skull of a European supposed to be that of the great traveller has been found. A later mail gives an account of the murder of Europeans by natives many years since, so that little doubt remains of the fate of the explorer. The question of the boundaries of the various colonies of Australia is again cropping up. A portion of the district on the Murray is 180 miles from Melbourne, across level country, but is 420 miles from its capital, Sydney, across the Blue Mountains and other ranges; the consequence is that judges and other officials visit this district by way of Melbourne.

Considerable attention has been turned, by a discussion to which we alluded in a previous number, to the capabilities of Khotan.

Practicable passes into this country are now being sought, and it is hoped that the vast region of Chinese Turkistan will ere long be in communication with our provinces. A M. Lejean has sent home to the French Minister of Instruction an account of discoveries on the Persian Gulf which are said to be most startling. The particulars are not yet published.

From Abyssinia but little news reaches us. Dr. Beke has been giving a lecture on this country, with his view of the complications, which does not altogether coincide with that of some others. The captives are still captives, the king says, to prevent their falling into the hands of the rebels that beset him. The notices in English newspapers come before this potentate, and do not mitigate his peculiar temper. Mr. Rassam has contrived to send secretly some private letters to this country. He states that all are in good health, the consul is fettered, and he himself has a chain on his leg; but they are treated with consideration and kindness by the king!

The information about central Africa is at present small. A Dr. Ori, a Tuscan, who spent some time in the Soudan as a physician, is about to publish his journal. The Doctor is well acquainted with many African dialects. Of Dr. Livingstone we know little more than his letter to the Royal Geographical Society, which is referred to later. He has not written again; but Dr. Kirk had obtained information of his having advanced some little way beyond the confluence of the Rovuma and Loendi along the former river. Since this a report has come through the same gentleman of the death of the traveller. Time alone will show whether this is to be classed with many other reported deaths, or is the sad finale of a grand career.

M. du Chaillu has published an account of his last African expedition, in a work entitled 'A Journey to Ashango Land,' which deserves more than a passing notice, on account of its significant bearing upon the progress of scientific exploration. M. du Chaillu has learned that English readers are not easily satisfied with the accounts brought home by travellers, but that, in order to obtain permanent fame for the explorer, it is necessary that such accounts should bear the strictest investigation. Both to the general reader, and to the man of science, this book cannot fail to be amusing; to the former, because it tells of marvellous hairbreadth escapes, and flatters the vanity of the civilized white by showing his superiority of race, for the "Great Spirit" (as the author frequently tells his readers that he was called by the poor savages) with his musical boxes and scientific instruments, seems to have been regarded as a kind of angel come down from heaven armed with smallpox to punish and beads to reward, as it might please his will and pleasure. To the scientific reader the book, coupled with the newspaper controversy on Natural History subjects between the author and Dr. Gray (*sic!* the former will pardon us if we borrow one of his ejaculations), exhibits the shrewd, adventurous traveller, driving his intellectual bargains, first abroad and then at home, and rendering an unconscious service to science by casting upon the public a heterogeneous mass of information from which the astute critic may easily sift the dross.

The author's "illustrious friends," Sir Roderick Murchison and Professor Owen, have served him well at home, and it is only a pity that they cannot induce him to share his African glories with one or more intelligent *whites* who would help him in the tropics in his photographic, trigonometrical, astronomical, and zoological labours, and would inspire confidence in much that he now writes, and which, although no doubt true, is looked upon with great suspicion.

Those hairy dwarfs, for example, have done less to establish our faith in the Darwinian theory than the contrasts which he unconsciously draws between the gorillas, the savages, his own "Commi boys," and himself! for if ever there was a complete gradation from man the brute to man the reasoner, there it is.

But we do not wish to underrate M. du Chaillu's labours. We are not merely ironical sceptics. He undoubtedly brought the wonderful gorilla to our doors, when it was a creature of fiction, and he stirred up other travellers and traders to seek the same zoological wonder with which some of our natural history museums are enriched. He brought or sent home other valuable specimens, has devoted his mind, as far as he was able, to the acquisition of scientific knowledge; has evidently controlled, to some extent, the desire to indulge in the narration of wondrous adventures, and seems to be gradually sobering down into an enterprising scientific traveller. We wish him a successful future; and next time he visits Africa, we trust that he may be more fortunate in his relations with the natives, and that he may not again lose his photographic apparatus.

Some time since we gave the arguments in favour of an open sea towards the North Pole. Dr. J. R. J. Hayes has advanced as far north as 81° 35′, the most northerly land ever reached by man; and hence he beheld a wide expanse of open sea. He was thus unable to continue the journey, but looks forward to making the attempt afresh, with the experience gained in his last expedition.

PROCEEDINGS OF THE ROYAL GEOGRAPHICAL SOCIETY.

The last letter received from Dr. Livingstone was dated 18th May last, from Ngomano, at the junction of the Rovuma River with the Loendi. The traveller had arrived here from Milkindany

Bay, 25 miles to the north of the mouth of the Rovuma, whence he had been obliged to start, as he could find no path for the camels through the mangrove swamps at the mouth. Ngomano is 30 miles further than Dr. Livingstone had advanced in 1861. The chief here was friendly, and disposed to assist towards the journey to Lake Nyassa.

Dr. Mann, in discussing the Physical Geography of Natal, showed how the colony was suited by its configuration for the cultivation of sugar, coffee, arrowroot, pineapples, bananas, and oranges, on the coast; and wheat, potatoes, and other crops of a temperate zone, inland; but that it could never support the vine, because the clouds and moisture of the summer prevented the grapes from ripening. The coast has but one harbour, Natal, capable of receiving at present vessels of 700 tons burden, whilst it may be improved considerably. The warmth of the coast may be attributed to that of the current of water, of about 78°.

A paper by Colonel Tremenheere, R.E., "On the Physical Geography of the Lower Indus," gave rise to much discussion. After a description of the plain of Scinde, and its peculiar formation, without natural drainage, the Colonel entered upon an account of the gradual silting up of the Kurrachee harbour by the deposit of the Indus, borne northwards by the current. The various facts on which this theory depended, and the theory itself, were denied by the Chairman of the Scinde Railway, the Engineer of the Kurrachee Harbour, and others more or less interested in the matter; whilst Colonel Tremenheere was defended by General Sir W. Gordon.

Captain H. H. Godwin Austin, of the Trigonometrical Survey of India, described the Lake Pangong, in Thibet, which is about 100 miles in length, and is situated, 14,000 feet above the sea, in a valley to the south-east of the Karakorum.

Dr. Baikie, who died at Sierra Leone on his way to England to enjoy a few months repose, after many years' work in conciliating the natives on the Niger, left "Notes of a Journey from Bida in Nupe on the Niger to Kano in Hansa." This journey occupied nine months, and the records of it are sufficiently exact and explicit to enable Dr. Kirk to complete a map of the district. The country was generally fruitful, of various appearance, and inhabited by rude, but intelligent and kind people. The slave-trade seems to have somewhat diminished in some of these districts. The object of the expedition—the recovery of the papers of Vogel and Overweg—was not successful, but a clue was obtained to their present position.

The Bishop of Mauritius furnished a paper on "A Visit to the North-East Provinces of Madagascar," which narrated the events of a journey undertaken in 1865. The country is described as beautiful and fertile, the harbours large and numerous, but the population small—the inhabitants being indolent, of a mild character, and subject to a dominant race—the Haves.

"A Diary of a Hill-Trip in Burmah" was furnished by Lieutenant T. H. Lewin, who in 1866 had to make his way with some danger through the Hill tribes up in the country lying between Bengal, Arrachan, and Burmah. These tribes are numerous and distinct from each other; of a Mongolian character, very barbarous, and speaking various dialects.

The discussion of a purely political topic—the choice of a site for the capital of India—was introduced by a paper by the Hon. C. Campbell, which recommended a spot on the Great Indian and Peninsular Railway, in the table-land of the Deccan on the Western Ghauts, 150 miles from Bombay. The climate is good for Europeans; it is within easy reach of the sea, though not too close; it is near the geographical and political centre of India, and has room for a European settlement around it. The principal drawback was a want of water, which might be supplied from a distance of four or five miles. The merits and demerits of Calcutta were discussed, as well as those of the site now indicated, and other localities were suggested; but the debate took almost entirely a political turn, and gave an opportunity to several eminent Indians to express their sentiments.

A letter from another African traveller, since dead, M. Jules Gérard, dated Mano, lat. 8° 10′ N., in the interior from Sherbro, on the west coast south of Sierra Leone, and supposed to have been written about a month before his death, from the upsetting a canoe in crossing the Jong river, gave some interesting details about the Kass country, which has never been visited by traders, but possesses abundance of ivory and cotton. M. Gérard had met with the usual obstructions offered by the chieftains on the coast.

'An Ascent of Mount Hood, in Oregon,' by the Rev. H. K. Hines, describes this mountain to be an active volcano, picturesquely situated, and of an altitude of 17,640 feet; a fact which is disputed. If, however, this be so, it is the highest mountain in North America.

A paper was read "On a Journey of Exploration in Eastern Oregon and Idalio," by Colonel C. S. Drew, U.S.A., and Mr. Robert Brown, F.R.G.S.; and at a subsequent meeting papers on subjects already treated of in former Chronicles; the "Exploration of the Purus River and the Rivers of Caravoza in Southern Peru," by Mr. W. Chandless and Don Antonio Ramondy respectively, were read and commented on.

9. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

AMONGST the publications of the quarter most deserving of notice ranks the volume of the Palæontographical Society for 1865, which has lately appeared. It contains four parts of as many monographs, and although we can convey no idea of their value in this Chronicle, we must not omit to give an outline of the contents of each of them.

The first contribution consists of Part I. of a monograph of the Foraminifera of the Crag, by Professor T. Rupert Jones, Mr. W. K. Parker, and Mr. H. B. Brady. From a zoological point of view it may be regarded as a supplement to Messrs. Jones and Parker's paper on Arctic and Subarctic Foraminifera, in the 'Philosophical Transactions.' Geologically, its chief value is as a record of the exact position and relationships of the different groups (whether they be considered genera, species, or varieties) of these lowly organisms, deduced from careful investigations; and it appears that notwithstanding the extremely variable nature of Foraminifera, the authors are enabled to recognize different zoological zones by means of the facies of the assemblages of these fossils which occur in them.

The next memoir is the first part of Dr. Duncan's "Monograph of the British Fossil Corals," being a supplement to the one by MM. Milne-Edwards and Jules Haime. The introduction is a very complete essay on the anatomy, physiology, and classification of corals, and well deserves a careful study. The description of the corals of the Brockenhurst beds will no doubt form the basis of future researches into the relationships of this and other deposits, which have been variously termed Lower Oligocene and Upper Eocene. The mollusca show the Brockenhurst strata to be related to those of Latdorf; but the corals are distinct. Dr. Duncan is therefore probably right in suggesting that the coral-fauna of the former deposit belonged to an oceanic and reef area, and that of the latter to a coast line. This instalment concludes with a description of some additional species of corals from the Eocene of the Isle of Wight and from the London clay.

The introduction to the next monograph, "On the British Fossil Crustacea belonging to the order Merostomata" (Part I.), by Mr. H. Woodward, is of the same character as that to the one just noticed, and deserves the same praise. It is followed by a Bibliography of the order, which does credit to the industry and research of the author, while the description of *Pterygotus anglicus*, which completes this part, is remarkably exhaustive, and is illustrated both fully and well.

Mr. Davidson's contribution to this volume consists of the commencement of the Silurian portion of his monograph of British Brachiopoda, and includes descriptions of the Silurnia species of the families *Lingulidæ*, *Discinidæ*, *Craniadæ*, and *Spiriferidæ*. It is prefaced by a bibliography of the subject, and by an essay on the Classification of the Silurian Rocks, written by Sir R. I. Murchison. As it requires a close study to appreciate this monograph, it is sufficient to observe that it exhibits the scrupulous accuracy, both in description and illustration, that is so characteristic of all Mr. Davidson's works.

We think we perceive in this volume the evidence of some additional care in the getting up and printing, more especially of the plates; those illustrating Dr. Duncan's monograph being very favourable specimens of English lithography.

In a former chronicle* we recorded the discovery near Mons, by Messrs. Cornet and Briart, of a limestone containing Tertiary fossils, apparently of Bracklesham age, beneath strata belonging to the Système Landenien (Thanet sands). MM. Cornet and Briart have since continued their researches, and have given the results in a paper entitled "Notice sur l'Extension du Calcaire Grossier de Mons dans la Vallée de la Haine."† Not only are they confirmed in their original conclusion, but they are enabled to prove the extension of the fossiliferous deposit (calcaire grossier de Mons) for a considerable distance. The weak part of the evidence, namely, the proof of the age of the Landenian is not, however, strengthened by this memoir.

In a paper "On the Structure and Affinities of *Lepidodendron* and *Calamites*," published in the 'Journal of Botany,' Mr. Carruthers has given his reasons for regarding these plants as Cryptogams, more highly organized than any existing members of the class; and for considering merely analogical, the arrangement of their tissues to that of certain *Cycadeæ* and *Cactaceæ*. Mr. Carruthers warns geologists against taking for granted "that the known conditions of the living species of a genus are true also of the fossil members of the same genus;" and he cites the case of *Elephas primigenius* in illustration. This warning, coming from a botanist writing on such a subject, should make geologists suspicious of the probability of any of the numberless speculations on the climate and conditions of the Coal-measure period.

Dr. Hector, Director of the Geological Survey of Otago, has published a 'First General Report on the Coal Deposits of New Zealand,' the contents of which will probably surprise many unacquainted with the recent Government publications relating to the geology of the colony. Both brown coal and true coal appear to be abundant in the north island, as well as in the south. Economically, the latter is of course by far the more important, and it is satisfactory to find that it makes a remarkably good steam-coal, notwithstanding its brittleness and its Mesozoic age, while Dr. Hector estimates its quantity at not less than four thousand millions of tons.

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* 'Quart. Journ. Science,' No. XI. p. 417.

† 'Bull. Acad. Roy. Belgique,' 2^me^ série, vol. xxii.

Another colonial publication which deserves mention is a memoir on the 'Physical Geography, Geology, and Mineralogy of Victoria,' by Mr. Selwyn, the Director, and Mr. Ulrich, one of the Geologists, of the Geological Survey of the Colony.

M. Tournouër, who has so long devoted his attention to the geology of the basin of the Adour, has lately published a memoir on the Tertiary deposits of the upper valley of the Saône, in the twenty-third volume of the 'Bulletin de la Société Géologique de France.' In this memoir, the author gives the results of a most careful and extended investigation into the geological structure of the district treated of; and gives, with considerable clearness, his views of the sequence of events which have produced the various phenomena which we are now called upon to interpret. These events appear to have been as follows:—At the termination of the Cretaceous period, or even before then, the deposits previously formed were upheaved, and lakes were hollowed out in the surface of the Cretaceous beds. In these lakes were deposited, during a period of oscillations of level, the strata characterized by *Limnea longiscata*, those by *Bithynia Duchasteli*, and those by *Helix Ramondi*. To this epoch succeeded a long period of calm, during which the Upper Miocene marine strata were deposited. After this, occurred another upheaval, followed by the establishment of another lake-period, in the deposits of which are found the remains of a fauna of the time of *Mastodon Arvernensis* and *Elephas meridionalis* (?). Then followed another change, coupled with a third upheaval, and the destruction of the last system of lakes; and during this period was formed the drift with *Elephas primigenius*. Hence we get to the existing order of things, and the confinement of the waters of the several rivers within their present limits.

We must not omit to record the publication during the past quarter of the Explanation to Sheet 33, of the Geological Survey Map, entitled 'The Geology of East Lothian, including parts of the counties of Edinburgh and Berwick,' by Messrs. H. H. Howell, A. Geikie, and John Young.

We have little space left to discuss the many papers contained in the last three numbers of the 'Geological Magazine;' but a few are too important to be passed over in a Chronicle of Geology. Mr. Carruthers's paper, "On some fossil Coniferous Fruits," is of considerable consequence, both geologically and palæontologically; from the former point of view because he shows that two species of cones, hitherto considered to be of Cretaceous age, are really of Tertiary date; and from the latter because he considers these, and some other cones, to be truly Coniferous, instead of Cycadean, as determined by Lindley and Hutton. Mr. Carruthers also departs from custom in referring the different species of cones found in the Secondary and Tertiary deposits to one group, for which he uses the general generic term *Pinites*, while more daring botanists have had no hesitation in assigning them to "the various sections, or so-called genera, into which *Pinus* is divided."

A very sensible paper, in the January number, "On Denudation, with reference to the Configuration of the Ground," by Mr. A. B. Wynne, inculcates the maxim that "all the forms of the land cannot be fairly attributed to any one kind of denudation with which we are acquainted;" and that the similarity of the general results involves their origin in some obscurity, "which may lead to error, if a prejudice exist in favour of either marine or subaerial agency." In the same number is a valuable abstract of a Danish memoir on Crinoids, by Dr. Lütken, which especially affects palæontologists, as it treats of the classification of the group generally; but there is one structural point which likewise demands consideration:—some Crinoids, especially Palæozoic forms, possess a central opening, terminating a proboscidean tube; this has generally been regarded as the mouth, and any other aperture as the vent. Dr. Lütken, however, shows that in the existing sea-lilies a proboscidean mouth does not exist, but that the intestine *always* ends in a short or long proboscidean tube; and he therefore considers that this is most probably the anus. In the recent *Actinometra* the mouth is eccentric, so that there is no reason why this should not have been the case in the fossil species; indeed, "it is the form, and not the place, that must decide if it is the anal-tube or the mouth."

The February number is full of interesting matter. Professor Owen describes the jaws and teeth of Cochliodonts; and Professor Huxley a new reptile (*Acanthopholis horridus*) from the chalk-marl of Folkestone, its stratigraphical position being illustrated in a paper by Mr. Etheridge. Professor John Morris gives some interesting information on the occurrence of "Greywethers" at Grays, Essex, which has not been generally noticed before. Then there are two controversial papers, one "On the systematic Position of Graptolites," by Mr. Carruthers, in which the author favours the view of their Polyzoan affinities; and the other "On the alleged Hydrothermal Origin of certain Granites, &c.," by Mr. David Forbes, in which the author impugns the conclusions at which Mr. James Geikie had arrived in his paper noticed in our last Chronicle,* which he supplemented by a note in the December number of the 'Geological Magazine.' Mr. Forbes is very hard on Mr. Geikie's Chemistry, Mineralogy, and *Petrology*. We should imagine, however, that Mr. Forbes would hesitate before seriously opposing the "hydrothermal" theory; and, in fact, his hesitation is so great as to lead to contradiction (*see* p. 58). It may be that Mr. J. Geikie's language is loose; but a good cause has often an unskilful advocate. However, the moral of Mr. Forbes's criticisms is doubtless true, namely, that Mr. J. Geikie has been too eager to generalize on data, and perhaps with knowledge, insufficient for the task.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

The number of the Geological Society's 'Quarterly Journal' for the past quarter contains few papers; but these are chiefly of considerable merit.

Professor Huxley's description of "some remains of large Dinosaurian Reptiles from the Stormberg Mountains, South Africa," is of considerable interest, on account of the uncertainty of the age of the fossiliferous strata occurring in that region. The most important of these remains belong to a new genus, named *Euskelesaurus* by Professor Huxley, having affinities with *Megalosaurus* and *Iguanodon*; but no very definite conclusion can be drawn from them respecting the age of the strata from which they were obtained, as Dinosaurian reptiles have been discovered throughout the Mesozoic formations—from the Triassic to the Cretaceous inclusive. Professor Huxley also remarks that "the affinities of the Thecodonts with the Dinosauria are so close that no one could be surprised at the occurrence of the latter reptiles in rocks of Permian age." According to Mr. Bain, the strata forming the Stormberg mountains are "piled conformably above the Karoo-beds, which have yielded the Dicynodonts and so many other remarkable true reptiles and Labyrinthodonts," so that future discoveries of fossils in the Stormberg rocks may enable us to place, at least, an upper limit to the possible age of the *Dicynodon*, about which there has been so much discussion.

The paper "On Marine Fossiliferous Secondary Formations in Australia," by the Rev. W. B. Clarke, is worth considering, as a great deal of speculation on the cause of the Mesozoic facies of the recent Australian fauna has been based upon the supposed absence of such deposits from the Australian continent; but we must refer our readers to the paper itself for the evidence brought forward by the author.

The most important paper in the journal is that by Dr. Duncan,

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* 'Quart. Journ. Science,' No. XIII., p. 121.

"On the Madreporaria of the Infra-lias of South Wales," as in it the author describes the occurrence of a coral-fauna, new to Great Britain, occurring in deposits of Liassic age at Brocastle, Ewenny, Sutton, Southerndown, &c., near Bridgend. Before the discovery of these corals, very few were known to occur in England between the Keuper and the zone of *Ammonites Bucklandi*, and as regards the number of species, they bore no relation to that of the associated mollusca. We have now, however, 26 new species from Brocastle, and 7 from the Sutton series, besides 5 common to the former locality and the zone of *Ammonites Moreanus* in the Côte d'Or and its equivalent beds, and 3 Triassic species from the Sutton stone, already described by Laube; making, in all, 41 species.

The conclusions drawn from these entirely new data must have a high interest for geologists who have taken part in the vexed question of the lower limit of the Liassic series. As will be seen by the title of his paper, Dr. Duncan adopts the term Infra-lias, used by continental geologists; but he makes the very suggestive remark—that "the Madreporaria abound at the base and at the upper part of the Infra-liassic series . . . . and that as a whole, the coral-fauna of the Infra-lias is more distinct from that of the true Lower Lias than the coral-fauna of any one of the Oolitic beds is from that of another." He correlates the Welsh strata in question with "the upper beds of the French and Luxembourgian Infra-lias," and we have seen that three Triassic species have lingered even so late as to be found at Sutton. It therefore becomes interesting to know how many Triassic forms are found in the beds at the base of the continental Infra-lias, because on this will depend the verdict to be given on the applicability of the term Infra-lias, from the evidence of the corals. But whatever name we use, we have recorded in this paper the very important fact that these rich coralliferous beds of Wales are the equivalents of the upper portion of the continental Infra-lias, namely, of the Calcaire de Valogne, the zone of *Ammonites Moreanus*, and the Grès Calcareux, which are superimposed on the equivalents of our zone of *Ammonites planorbis;* consequently the Welsh beds must be more recent than that zone.

In a paper on the structure of the Xiphosura, Mr. H. Woodward discusses the relations of the Palæozoic genera *Eurypterus* and *Pterygotus* to the existing genus *Limulus*. At first sight the affinity of the recent with the fossil types does not appear very evident, and, even when the resemblances are pointed out, it does not seem to be striking. But recent discoveries have shown that these are the extreme members of a long series of forms, and as each gap has been filled up, the comparison has, of course, become more easy and natural, until now Mr. Woodward considers the materials at his command sufficient to form the basis of a scheme of classification. He proposes to treat the groups Eurypterida and Xiphosura as suborders of Dr. Danas's order Merostomata, the former including the genera *Eurypterus*, *Pterygotus*, &c., with several forms which have a more limuloid aspect, notably *Hemiaspis*.* In the suborder Xiphosura he includes the recent genus *Limulus*, and (what is very important) two Carboniferous genera, namely, *Belinurus* and *Prestwichia*, which are, together, represented by six species. The distribution of the fifteen species of *Limulus* is worth notice, as showing the suborder to have been represented in every great period *since* the Carboniferous, there being one species known from the Permian, one from the Trias, seven from the Oolites, one (doubtful) from the Chalk, and one from the Tertiary; and there are four recent species.

A short paper by Dr. Duncan, "On some Echinodermata from the Cretaceous Rocks of Sinai," is of some interest, as showing that these fossils prove (1) that the Sinaitic strata are the equivalents of our Upper Greensand; (2) that they are on the same horizon as the Cretaceous strata of South-eastern Arabia, and of Bagh on the Nerbudda; and (3) that the conclusions drawn by Dr. Duncan from the fossil Echinoderms of the latter localities † are probably well founded.

Mr. J. W. Flower's paper "On some Flint Implements lately found in the Valley of the Little Ouse river at Thetford, Norfolk," is a record of the discovery of implements of the St. Acheul type, in gravel-beds in that locality, situated in a position analogous to that of other implement-bearing deposits. Beyond this, however, it is of considerable interest, as the author's researches have led him to doubt the probability of Mr. Prestwich's conclusion that these gravel-terraces were brought into their present position by river-action. We cannot give all his arguments; but one, especially drawn from the case recorded in the paper, deserves attention. Flint implements have been found in gravel-deposits in three different river valleys, very near to each other,—namely, of the Waveney, the Little Ouse, and the Larke. The two former rivers rise in a marsh within a few yards of one another, and then flow in nearly opposite directions; and while at the present day their volume, even at their highest floods, is quite inadequate to do the work required of them by Mr. Prestwich's theory, in their narrow watershed we can find no high land from which the snows of former periods could have given forth the torrents of water invoked by Mr. Prestwich in the case of the valley of the Somme. Other arguments are also used by Mr. Flower with much ingenuity, and his paper deserves the careful consideration of "Quaternary" geologists.

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[*] See 'Quart. Journ. Science,' No. IX. p. 107.

[†] See 'Quart. Journ. Science,' No. IX. p. 105.

The last paper we have to notice is a very short one by Professor W. C. Williamson, "On a Cheirotherian Footprint from the Base of the Keuper Sandstone of Daresbury, Cheshire," which is of more importance than its title indicates, as the footprint is more Cheirotherioid than Cheirotherian, and is "distinctly that of a *scaly* animal." The following conclusion is also at variance with the title:—"Had the impression not exhibited the scaly structure, it would probably have been described as 'Cheirotherian,' but I do not believe that it belonged to a Batrachian animal. It is Saurian, if not Crocodilean, in every feature, and as such, constitutes an interesting addition to the palæontology of the English Keuper."

We are sorry to be obliged again to chronicle the death of two eminent geologists, namely, Mr. James Smith, of Jordan Hill, F.R.S., F.G.S., &c., a very old and eminent explorer of Postpliocene or Quaternary deposits; and Professor J. A. E. Deslongchamps, of Caen, a Foreign member of the Geological Society, and one of the foremost of French palæontologists; both of whom have become lost to us after a long life of devotion to our science. It is with different feelings that we record the untimely death of Mr. F. J. Foot, M.A., &c., in an effort to save the lives of two persons from drowning. Mr. Foot was on the staff of the Geological Survey of Ireland, and was a very promising and active botanist and geologist.

The Council of the Geological Society have awarded the Wollaston gold medal to G. Poulett Scrope, Esq., M.P., F.R.S., F.G.S., &c., in recognition of the highly important services he has rendered to geology by his examination and published descriptions of the volcanic phenomena of central France, and by his works on the subject of volcanic action generally throughout the world; and the balance of the proceeds of the Wollaston Donation Fund to Mr. W. H. Baily, F.G.S., to assist him in the preparation and publication of an illustrated catalogue of British Fossils.

10. MINING.

The continued state of extreme depression which prevails in the mining districts renders our chronicle a sad one. In Cornwall and Devonshire more than half of the mines—that is, nearly 300—are now idle, which were in active operation a few years since. Careful examinations made in each of the mining districts of south-western England enables us to give the following list, as a very close approximation, to the real numbers of the miners who have emigrated.

From Tavistock and Ashburton Districts	691 Men.
„ Liskeard	100 „
„ St. Austell and St. Blazey	275 „
„ Redruth and St. Agnes	800 „
„ Camborne	150 „
„ Hayle	550 „
„ St. Ives and Lelant	150 „
„ St. Just	600 „
„ Helston and Wendron	100 „
„ Marazion and Tremayne	450 „
	3,366 Men.

It must be remembered that these are able-bodied men, the youngest and most active of the mining population. About a thousand of these have found employment in the collieries of Wales and Scotland, and on the lines of railway which are now in progress—especially around the Metropolis. From the largest copper-mining district of Cornwall we hear of three mines, paying about 1,000*l.* per week in agency and labour, which are continuing to do this at an actual loss of 15,000*l.* a year. Should these mines succumb beneath the pressure of the times, the withdrawal of the 52,000*l.* now distributed as wages, would spread ruin on every hand.

Lead-mining is not affected to the same degree as tin and copper, although the condition of the metal market is influencing even the Lead-mines.

Coal-mining is, and has for some time, been very brisk; while, on the other hand, the iron trade cannot recover its position.

The returns of our mineral produce for the year 1866 are not yet complete. They are, however, sufficiently advanced to enable us to state that the production of Tin will have been unusually large, although nearly every ton of tin ore will have been sold at a loss; of Copper ore, from British mines, there will have been a falling off; but the importations of Foreign Copper will have been large. Lead and the other metalliferous minerals will remain much as they were in 1865. Nearly, if not quite, one hundred millions of tons of Coals will have been produced in the United Kingdom.

In the process of coal-mining, this quarter will be marked by the terrible accidents, by explosion—at the Oaks Colliery in the Barnsley district, and at the Talk-o'-the-Hill, near Hanley, in Staffordshire, by which nearly four hundred lives have been sacrificed. These casualties have naturally directed attention strongly to the system of colliery inspection. We do not learn whether it is the intention of the Government to propose any measures calculated to secure greater attention in the particulars of ventilation and lighting.

In the midst of the extreme depression which prevails in our metal mines, two members of the House of Commons talk of new legislation—one bringing in a bill to rate metal mines to the poor;

the other proposing to found a bill for their better regulation, on the report of Lord Kinnaird's Commission. Upon reflection, we should hope both these measures will be postponed.

We have, from time to time, noticed the coal-cutting machines which have been introduced. We have now to record an important movement in connection with them. A committee, consisting of some of the largest coal proprietors of Lancashire and Cheshire, have offered three prizes, of the respective values of 500*l*., 200*l*., and 100*l*., for the first, second, and third best machines for the cutting of coal. The machines must be adapted to the following requirements:—Thickness of seams, from two to nine feet. The dip, or inclination, from horizontal to an angle of 20°. Maximum size of tub or wagon used in the mines, three feet six inches by three feet, and three feet in height. Gauge of road, from one foot six inches to two feet three inches. It is considered desirable that the machine should be as light and as easily moveable as possible.

The committee express their belief that compressed air is the proper motive power for working coal-cutting machines. We hope this does not mean, that they exclude machines worked by water pressure from their consideration. The facility with which power is transferred, with scarcely any loss by water, as compared with the great loss when air is employed, renders it advisable that water pressure should be equally considered. Inventors must furnish machines not later than the 1st of November in the present year. We quite expect from this, that we shall soon find coal-cutting machines in general use in our collieries.

A successful application of the Electric Telegraph has been made by Messrs. T. B. and W. B. Brain, in the Trafalgar colliery in the Forest of Dean. A great difficulty arose in the conveyance of coal from the workings to the shaft, owing to the declivity of the seam under work. Indeed, the steepness was such, that the ordinary method of hauling became impracticable. To meet this difficulty the engine at bank was brought into requisition,—to which was applied a length of chain reaching to the end of the workings, the shaft being 200 yards deep, and the dip workings extending to a considerable distance. To ensure safety, instantaneous communication was necessary, and electricity was thought of. An electric bell is placed in the engine-house, and another near the top of the dip-workings; these are connected by wires carried down the pit and continued along the road. The great danger was the liability of injuring the men, during the rapid ascent or descent of the trucks. To avoid this, "electrical tappers" are placed along the road, and thus at any point a man can signal to stop or start the engine. The old mode of signalling between the "hanger-on" and the engine-man has been superseded by this new arrangement. An instrument is placed in front of the engineer, and at the bottom of the shaft the hanger-on is provided with a pair of electrical tappers, coloured respectively white and red. The white tapper being touched, the bell is rung in the engine-house, and the words "Go on" appear on the dial; on touching the red tapper, the bell is struck as before, and then the word "Stop," in white letters on a red ground—as indicative of danger—appears.

The salt-mines of the Nevada Territory are the most considerable in the United States. A single bed of rock-salt occupies a superficial space of 52,000 acres, and produces annually two million bushels of a mineral which gives 95 per cent. of pure salt. If the ground is pierced to the depth of from 250 feet to 300 feet saline water rises so rapidly and with such force that all the workings are interrupted.

Coal is stated to have been discovered in India, at Nursingpore, in the immediate neighbourhood of the Great Indian Peninsular Railway. This discovery, if the quality of coal is good, is of great importance.

In a communication "On Gun Cotton and its Use in Blasting," made by Messrs. T. Prentice and Co., to a contemporary journal* they state:—"We have lately prepared a very condensed charge, one inch of which will be found equal to six ounces of powder. Of our 1¼-inch diameter, five inches in length are equivalent to one pound of powder, and can be supplied at 4½*d.* By the use of this in hard granite rock, a large saving in boring is effected: the charges slip readily into the hole, leave no residue on the side, and only require the fuse to be connected with the uppermost piece. The total absence of smoke, comparative freedom from danger, portability and convenience of form, combined with saving in labour and material, are advantages which are bringing Gun Cotton largely into use."

We quote this passage, and can, from our own knowledge, confirm much that is stated. Upon one point we must, however, remark. That there is a total absence of *visible* smoke is admitted on all hands; but in the combustion of Gun Cotton, gases are formed, which, floating in the atmosphere of a close end in a mine, may exert a most injurious effect on the miner, should he incautiously resume his work too speedily after the blasting of a hole.

MINERALOGY.

In the February number of the 'Philosophical Magazine,' Mr. David Forbes, F.R.S., continues his "Researches on the Mineralogy of South America." The present paper contains a sketch of the "General Mineralogy of Chili," the author having spent four years in examining the country and visiting its chief mineral localities. Some idea of its riches may be gained from Forbes's catalogue of the species which have hitherto been discovered, amounting to upwards of two hundred, the greater number of which occur in the intrusive rocks and their associated mineral veins. An examination of this list shows that many species which are abundant in mineral deposits in other parts of the world, are here found only in insignificant quantity, while many others are altogether absent. The minerals are classified according to their geological occurrence, the richest repositories being what are designated as the "post-oolitic diorite eruptions." From the author's observations, it appears that the occurrence of the Chilian minerals, so far from being casual or accidental, bears a definite relation to the rocks in which they are found, "similar minerals, or classes of minerals, accompanying the eruption of similar rocks;" and even where the same species occurs under different conditions, each occurrence is marked by distinctive characters of its own, either chemical or crystallographical.

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* 'Mining Journal.'

The same able mineralogist has commenced in the 'Chemical News' a series of articles "On the Application of the Blowpipe to the Quantitative Determination or Assay of Certain Metals." These papers, which will serve as an introduction to the author's forthcoming treatise on the subject, cannot fail to prove of essential service to the mineralogical student. While noticing the recent literature on the Blowpipe, attention should be directed to Professor Theodor Richter's essay on "The Blowpipe, and its Application in Chemical, Mineralogical, and Assaying Investigations" (Das Löthrohr und seine Anwendung bei Chemischen, Mineralogischen und Docimastischen Untersuchungen). This essay, which will be read with much interest,—Professor Richter being himself a perfect master of the Blowpipe,—appeared in the 'Festschrift,' published a few months back in commemoration of the hundredth anniversary of the foundation of the Freiberg Mining School; and our English readers are referred to an analysis of the paper in an article, "On Mining Education in Germany," which appeared in a recent number of the 'Journal of the Society of Arts.'*

Among the various substances which pass in commerce under the general name of Jade or Nephrite, is a light-green mineral from Easton, in Pennsylvania, which has recently been examined by Dr. Emmerling, of Freiburg.† Except, perhaps, in point of toughness, it possesses none of the properties of true jade, and especially lacks the characteristic splintery fracture; whilst in chemical composition it appears to be equally distinct, consisting of certain silicates and carbonates, the relations of which may be best shown by transcribing the Doctor's somewhat unattractive formula:

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* *Op. cit.*, January 11, 1867, p. 113.

† 'Neues Jahrbuch für Mineralogie, u.s.w.,' 1866. Heft 5, p. 558.

$$\text{“}18\,HO + 5\,Ca\,O, CO_2 + 7\,RO, Si\,O_2 + 5\,R_2O_3,\ Si\,O_2 + 3\,(Mg\,O)_3\,(Si\,O_2)_2.\text{”}$$

Until more shall be known as to the history of this complex mineral, Dr. Emmerling proposes to distinguish it as *Pseudonephrite.*

The eminent Russian mineralogist, M. Kokscharow, has published the results of his observations "On the Crystalline System and the Angle of Sylvanite" (Ueber das Krystallsystem und die Winkel des Sylvanits).* This mineral so rarely occurs crystallized, that the system to which it belongs has always been questionable, Mohs having described it as rhombic, while G. Rose regarded it as oblique. Availing himself of some well-defined crystals recently come into his possession, the author has undertaken a complete investigation of the mineral, the results of which confirm Rose's determinations as to the oblique character of the crystals.

In a paper "On certain Phenomena observed in Natrolite" (Ueber einige Erscheinungen, beobachtet am Natrolith),† Professor Kenngott describes the singular behaviour of this mineral in relation to heat. When small colourless transparent crystals of natrolite are slowly heated, they gradually become white and opaque, without losing their crystalline form; but if further heated, under proper conditions, these altered crystals lose their colour and opacity, and return to their original condition. The author explains these appearances by supposing the mineral to be constituted according to the following expression:—

$$\text{“}Na\,O, 2\,HO + Al_2\,O_3, 3\,Si\,O_2.\text{”}$$

It will be observed that the soda, instead of being combined with a portion of the silica, as usually represented, exists in the state of a free hydrate, and the first effect of exposure to heat is to expel the water from this hydrate, thus leaving the soda free, the molecular change induced giving rise to the opacity; but when the altered mineral is further heated, the soda combines with the silicate of alumina to form a clear fusible compound; and hence the crystals regain their transparency. The author perceived that if this view of the constitution of natrolite be correct, the mineral in its natural state should give an alkaline reaction, from the presence of free hydrate of soda; and this sagacious inference was fully verified by his experiments. When powdered natrolite is moistened with distilled water, it gives a strong red tint to turmeric paper, and restores the blue colour to reddened litmus.

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* 'Mélanges Physiques et Chimiques,' tome vi., liv. 5, p. 537.

† 'Neues Jahrbuch für Mineralogie, u.s.w.,' 1867, Heft 1, p. 77.

Kenngott's observations are of considerable interest, from their bearing on the constitution of other zeolitic minerals.

Among the researches conducted in the laboratory of Zurich, the results of which have lately been published in the 'Journal für praktische Chemie,' we notice several mineralogical investigations. Herr Städeler has chemically examined the topaz, and the silicate of iron called lievrite; while Dr. Wartha has investigated the minerals pennine and wiserine. The last of these papers is of interest as showing the folly of rashly instituting new species. *Wiserine* is a Swiss mineral occurring in pale clove-brown tetragonal crystals, resembling those of zircon. Its chemical composition was not well known, but it was supposed to contain silica and titanic acid. This is, however, entirely disproved by Dr. Wartha's analysis, which shows it to be a phosphate of yttria, agreeing with the Norwegian species known as *Xenotime*. Its occurrence is notable as being the first yttria-bearing mineral found in Switzerland.

Several other papers in the same journal merit the attention of the mineralogist. The green colour presented by many sandstones, marls, and other sedimentary rocks, is usually referred to the presence of disseminated granules of *glauconite*—a mineral which, although by no means confined to any particular geological age, is especially abundant in certain Cretaceous deposits, such as the typical "greensand" of our own country. So difficult is it to dissociate these mineral-grains from the rock in which they are embedded, and so readily do they suffer alteration by the action of decomposing influences, that the analyses which have from time to time been published present discrepancies of such magnitude, as to induce Dr. Haushofer to thoroughly examine the mineral with a view to determine its true chemical composition. In his paper "On the Composition of Glauconite,"* he publishes no less than seventeen original analyses of this mineral from different Bavarian rocks, obtained through Professor Gümbel. From these researches he concludes that all the varieties of glauconite are referable to a single species, but that their composition is not reducible to one general expression. The author calls attention to the relation between the constitution of the mineral in question and that of certain varieties of seladonite, or green-earth; at the same time expressing a belief that many so-called chloritic rocks are in reality glauconitic. In all cases the mineral appears to be a secondary product, derived from the surrounding rocks. According to Ehrenberg the grains often consist of the casts of microscopic foraminifera, and hence it is usually assumed that organic substances have been concerned in the formation of the mineral; an assumption which Haushofer is led to doubt, from the striking paucity of organic remains in glauconitic rocks. All the analyses show a notable proportion of potash, and the author refers to the benefits which plants must derive from growing upon soils resting on rocks rich in glauconite.

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* 'Journ. für praktische Chemie,' 1866, No. 6, p. 353.

As the effect of heat on minerals is always a subject of much interest to the geologist, we call attention to Dr. Elsner's researches "On the Behaviour of certain Minerals and Rocks at a very high Temperature" (Ueber das Verhaltung einiger Mineralien und Gebirgsarten bei sehr hoher Temperatur).* The investigations were conducted in the furnaces of the Royal Berlin Porcelain Manufactory, at temperatures between 2,500° and 3,000° Centigrade.

In the Chronicles of last quarter we described what was called the "Colorado Meteorite." Another mass has since been discovered in the same territory, and it is therefore proposed to name each after its special locality, distinguishing the older meteorite as the "Russel Gulch" iron, and the recently discovered one as the "Bear Creek" iron. The latter consists of nickeliferous iron, associated with magnetic pyrites, schreibersite, and other meteoric minerals. The following is Professor J. Lawrence Smith's analysis of the iron:—†

Iron	83·89
Nickel	14·06
Cobalt	0·83
Copper	Minute quantity.
Phosphorus	0·21
	98·99

In the same Journal Professor C. U. Shepard proposes a new classification of meteorites.

Those who are acquainted with Dr. Viktor von Lang's high position as a crystallographer and physical optician, will welcome the appearance of his recently-published 'Treatise on Crystallography.' ‡ To most of our English readers Dr. Lang will probably be well known, from his former connection with the British Museum, and from the Memoirs which he published in conjunction with Professor Maskelyne. He resigned his appointment in this country for a professorship in the University of Grätz, and he at present occupies a chair in the University of Vienna. The work before us is a comprehensive treatise based on Professor Miller's system of crystallography; but, being entirely free from the popular element, it will probably be read with profit only by the advanced student.

In the district of Beechwood, Sebastopol Creek, in Australia, a new diamond has been found, weighing a carat and one-eighth. It was discovered at the depth of 250 feet, amongst little blue and white topazes, hyacinths, zircons, tourmalines and stanniferous sands.

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* 'Journ. für praktische Chemie,' 1866, No. 21, p. 262.

† 'Silliman's American Journal of Science and Arts,' Jan., 1867, p. 66.

‡ 'Lehrbuch der Krystallographie,' von Viktor von Lang. 8vo. Wien, 1866, pp. 358.

The phosphoresence of hexagonal blende has recently claimed the attention of M. Edmond Becquerel. Although no really new fact has been discovered, a step has been taken towards establishing the relation existing between the solar phosphorescent rays and the other rays of the solar spectrum. We refer our readers to the original paper.*

A Californian newspaper informs us that about three miles north of Ione in that country, there is an isolated mountain, which might be called a mountain of Agates, so thickly is it covered with those concretionary masses. They are described as being like large potatoes, generally of an oval, but sometimes of a globular form. When cut and polished, it is said they are of exceeding beauty.

A communication has lately been made to the Academy of Sciences of Paris, on the remarkable Selenides which were discovered some six years since at Cacheuta, in the province of Mendoza, at the lower part of the Andes, and which have lately been examined by M. Domeyko. The seleniferous minerals appear to be of three varieties, in combination with silver, copper, and lead. The percentage of selenium varied between 22·4 and 30·8 per cent.

METALLURGY.

The past quarter has been singularly barren of results in any of the processes of smelting or preparing metals. The two following notes are the only ones, indeed, which even the scientific periodicals of Europe enable us to give.

At the meeting of the Chemical Society, on February 7th, Dr. Matthiessen read an interesting communication on Alloys. Many of the examples given appear to promise to be of much practical utility. This paper has been more fully noticed in the report of the Proceedings of the Chemical Society.

M. H. Caron has been making some interesting experiments on the Absorption of Hydrogen and Oxygen by Copper during fusion. Many of the results are of considerable interest; but as the investigation is incomplete, and as M. Caron promises to publish shortly the result of his experiments relative to the action of carburetted hydrogen and of carbon upon copper in fusion, we postpone our more detailed notice until the whole question is before us.†

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* See 'Les Mondes,' tome xii., p. 521.

† See 'Les Mondes,' vol. xiii., p. 42.

11. PHYSICS.

Light.—Some experimental researches on the indices of refraction of saline solutions have been communicated by M. Le Verrier to the Academy of Sciences. His aim has been to ascertain whether the law, as laid down by Biot and Arago relative to gaseous mixtures, was equally true for liquids. Having experimented upon 153 solutions, he arrives at the following conclusions, giving at different temperatures for each body, its chemical composition, specific gravity, and index of refraction.

The number representing the index of refraction varies according to the temperature. From 50° F. to 203° F. this variation often attains the hundredth part, and is greater in proportion as the liquid is the more concentrated. Its refringent power diminishes when the temperature is increased, and this diminution from 50° to 203° is about the thousandth part. The dispersion also diminishes with the temperature. In the same interval the distance between the two lines A and B of the spectrum may present a difference of a thousandth part. The law of Biot and Arago, that the index of a mixture of two gases is the mean between that of the two elements which constitute it, is therefore not strictly true in its application to liquid mixtures, but it may be regarded as a very close approximation, differing little from the truth, for a great number of saline solutions.

When Nicol's prisms are used as polarizers or analyzers in delicate optical measurements, an anomaly is frequently remarked: the azimuths of extinction do not occur at a distance of 180°. The error can amount to several tens of minutes. This error would be fatal to the use of the Nicol's prism if the cause could not be discovered, diminished, and remedied. M. Cornu first pointed out this cause, and he has given the following explanation:—The axis of rotation of the prism, or rather that of the instrument which carries it, does not coincide with the plane of the principal section; hence the ray which traverses takes different directions in the prism according to the azimuth, and the polarization to which it is subject is not parallel to the plane of the optical symmetry of the crystal. When the lines of entry and emergence of the prism are quite parallel, it can be regulated by trial; in general the error will be only alternated and not annulled; but it may be eliminated in proceeding by crossed observations. In fact, it is easy to demonstrate by a very simple calculation and by direct observation, that the error e of the normal azimuth is given by the formula

$$e = A(z + a);$$

A and e being the contents; z the observed azimuth, it is easy to deduce that the mean of the readings of the azimuths, which should strictly differ by 180°, gives, after the subtraction of 90°, the real azimuth. The error is eliminated of its own accord, if we choose for the measurements of the azimuths the mean of two positions of extinction, whether for the analyzer or for the polarizer.

M. E. Javal has described a new instrument which he calls the *Iconoscope,* intended to give relief to plane images examined with the two eyes. From the description we judge that this is an instrument similar to one which has long been known in England. It consists of an arrangement of prisms so placed that each eye receives an impression from the same point of view. On looking through the instrument at a picture, the eyes always preserving the same amount of convergence and being thereby unable to judge that the objects are on a flat surface, the painting has a semblance of relief.

HEAT.—In the second part of a memoir "On the Changes of Temperature produced by the Mixture of Liquids of different Natures," recently published by Messrs. Bussy and Buignet, the following very important conclusions are arrived at:—1. In all the cases under examination, with one sole exception, the calorific capacity of the mixture is a little superior to the mean capacity of the elements. 2. By a singular opposition, the liquids for which the increase of bulk is the most considerable, are exactly those which develop most heat at the moment of their union, such as ether and chloroform, alcohol and water, sulphuric acid and water. Meanwhile, the only instance hitherto noticed of diminution of bulk is the mixture of *chloroform* and *sulphide of carbon,* the decrease of temperature taking place at the moment of the union. 3. Independently of the loss of heat resulting from the changes of volume, there exists a cause which produces alone an absorption of heat—an absorption which can be sometimes equal and even superior to the heat given out by the combination of the liquids. This cause, perhaps, may proceed from the separation of the homogeneous particles necessary for the *diffusion* of the liquids.

M. Fizeau has continued his researches on the dilatation of crystals. He has experimented upon several series of salts presenting a great analogy with each other—such as chlorides, bromides, and iodides—expecting that this analogy would be manifested by the manner in which crystals are influenced by the action of heat. His previsions are in general confirmed, and in the course of his studies he has discovered a singular anomaly, and one which constitutes a real discovery. While the coefficient of dilatation of all the chlorides, bromides, iodides, is positive, in the same manner as it is for all substances experimented upon up to the present day, the coefficient of dilatation of *iodide of silver* is alone negative, so that this salt, instead of dilating, really contracts. Raised to a temperature of 40° C., the coefficient is $-0{\cdot}00000139$. This coefficient is besides variable with the temperature and the direction in the interior of the crystal. In the direction in which the contraction is greatest, parallel to the axis, it is the $\frac{1}{7000}$ part for 100° C., about a tenth of the dilatation of mercury.

M. Matteucci has experimented on the adhesion of air to metallic surfaces. He heats plates of platinum in a current of oxygen or hydrogen; then he places them, while yet hot, in a closed apparatus containing one of the above-named bodies. Immediately there is a diminution of volume of the gases, and a formation of aqueous vapour by the combination of oxygen and hydrogen. It may happen that in the case of platinum the adhesion of the gases is not only to the metallic surface, but also in the interior of the metal itself. Metallic platinum is generally formed by hammering spongy platinum—a substance which has the property of exciting the combination of certain gases; hence it will not be unreasonable to believe that the molecular interstices opened by the heat would retain the gases, and thus cause their combination under the influence of other bodies in contact with them.

Mr. Crookes has drawn attention to a curious result of the very severe frost experienced at the commencement of this year. Under the combined influence of cold and vibratory motion, large masses of glycerin were noticed to have assumed the solid crystalline state. About five tons of glycerin, in casks of eight cwt. each, were recently imported from Germany, by the firm of Burgoyne, Burbidges, and Squire. When they left the factory the contents were in their usual state of viscid fluidity; but on arriving in London, they were found to have solidified to a solid mass of crystals, so hard that it required a hammer and chisel to break it up.

A large block of this solid glycerin, weighing several hundredweight, suspended in a somewhat warm room, took two or three days to liquify; and a thermometer inserted in the fusing mass indicated a constant temperature of 45° F. In small quantities, the crystals rapidly fuse when the bottle containing them is placed in warm water. In quantity the solid glycerin looks very like a mass of sugar-candy. The isolated crystals are sometims as large as a small pea; they are brilliant, and highly refracting; when rubbed between the fingers they are very hard, and they grate between the teeth. Their form appears to be octahedral.

The crystals, separated as much as possible from the mother liquor, and then fused by heat, form a clear and nearly colourless liquid, slightly more viscid than usual, which possesses all the physical and chemical properties of pure glycerin.

Some of the fused crystals have been exposed for several hours to a temperature of 0° F. without solidification taking place. The only result was that the liquid became more viscid.

The cause of the crystallization is not very clear. The most probable explanation is, that the vibration of the railway journey across Germany, added to the intense cold to which the glycerin was simultaneously subjected, enabled the particles to arrange themselves in a regular form. The phenomenon then becomes analogous to the crystallization of wrought iron under the influence of vibration, and the gradual solidification of syrupy solutions of organic alkaloids.

Mr. Skey, Analyst to the Geological Survey of New Zealand, has discovered the curious fact that if tungstic acid is made red-hot, and then brought in contact with a cold surface, it assumes a black colour, which is permanent in the air. The change in colour here produced appears to be due to the presence of the oxide of tungsten. The effect of a sudden refrigeration of tungstic acid, therefore, is to deoxidize it. If the hot acid is dropped into kerosene oil, the same effects follow.

M. Becquerel, in his name and that of his son, M. Edmund Becquerel, has presented to the French Academy a new series of observations, thermometric and hygrometric, taken simultaneously in free air and under trees, the general results of which may be summed up as follows:—In summer the mean temperature in free air slightly exceeds that under the trees; in winter the contrary is the case. The trees, in spite of their inferior conductibility, very slowly assume a temperature in equilibrium with that of the air. The diurnal maximum takes place towards midnight under the trees, whereas it occurs towards three o'clock in the afternoon in free air. A little more rain falls three kilometres from the wood than at its verge or in the interior. The climate under the trees is therefore a sort of sea-climate, and this conclusion of the thermometric and hygrometric observations is confirmed by numerous facts of vegetation.

The Steam Ice-Machines of M. Toselli, are at present attracting some attention in Paris. An ice-producing machine capable of forming 22 lbs. of ice per hour, or nearly 2 cwts. per day, is a square parallelopiped 9 feet 2 inches long, 6 feet 3 inches wide, and 6 feet 5 inches high. It consumes nearly a halfpennyworth of charcoal for every kilogramme of ice formed, and only requires the attention of one man to set it at work and to give the necessary movement to the circulation of the water The machine costs 180*l.* We believe that the principle on which it is based is the rapid vaporization of a highly volatile liquid, the necessary supply of heat being taken from the water to be frozen.

A somewhat interesting discussion has been going on in the 'Chemical News' for some time past, on the subject of Standard Thermometers. Some of the facts elicited appear not to be known so much as they deserve. It appears that the zero points of all thermometers, as a rule, rise in a month or so after the instruments are made. This rise varies generally between ½° and 2°. The bulbs of the best thermometers should therefore be blown some months before the instruments are pointed. In this manner the greater part of the error may be avoided. Even after all due precautions have been taken, the thermometer should from time to time be either compared with another standard which has been repeatedly checked, or when this cannot be done, its zero should be independently tested by means of melting ice. The use of boiling-water is objectionable for the purpose of testing, as it has a tendency to permanently raise the zero of the instrument, even if it has been unchanged and correct before immersion. The most likely cause of rise is the one-sided pressure of the air. The bulb does not acquire, on cooling, its original size for some months. Every thermometer loses its accuracy, for many months, whenever it has served for the determination of higher temperatures; and there are very few thermometers in use in chemical laboratories that do not come under this head. An instrument, after adjustment, can only once be used for accurate determination of boiling-points without readjustment—a circumstance always lost sight of in chemical researches, and which explains, no doubt, many discrepancies between statements of different authors.

We welcome, with pleasure, a very excellent text-book on the subject of Heat.* A work of this sort has been long wanted for the higher class of schools, and for students at college; and the author, who is Examiner at two of our modern universities, where physical science is directly encouraged, has had ample opportunities of learning the wants of the students of the present day. The book which he has now given to us is concise, without losing in accuracy, or being obscure, and it embraces all subjects that could be included under the question of heat, and treats of the latest developments of the science, as discussed among physicists of the present day. The discussion of perpetual motion, and the connection therewith of the questions of dissipation and conservation of energy, may be mentioned as of especial interest. Throughout the work theories give way to facts, the unknown is grouped markedly from the known, and the methods of practical application of such groupings of facts are fully explained by general formulæ. With this work, Professor Miller's 'Chemical Physics,' Professor

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* 'An Elementary Treatise on Heat.' By Balfour Stewart, LL.D., F.R.S. Oxford: Clarendon Press. London: Macmillan & Co.

Tyndall's 'Heat as a Mode of Motion' (and we hope soon to add to these the volumes of Sir William Thompson and Professor Tait on "Natural Philosophy," promised for this series), the student of this year will possess advantages which have never before fallen to the lot of any one whose object is to acquire a thorough knowledge of physics.

ELECTRICITY.—Two very important papers on Electricity were presented to the Royal Society on February 14th. They are on almost the same subject, and are interesting, as showing how the same idea in the minds of two profound electricians becomes developed into an important discovery,—alike as far as the principle is concerned, but widely differing in ultimate results, and in the instrumental means adopted to obtain the desired end.

The first paper was by C. W. Siemens, F.R.S., "On the Conversion of Dynamical into Electrical Force, without the aid of permanent Magnetism." The apparatus employed in this experiment was an electro-magnetic machine consisting of one or more horseshoes of soft iron, surrounded with insulated wire, in the usual manner; of a rotating keeper of soft iron, surrounded also with an insulated wire; and of a commutator connecting the respective coils in the manner of a magneto-electrical machine. If a galvanic battery were connected with this arrangement, rotation of the keeper in a given direction would ensue. If the battery were excluded from the circuit, and rotation imparted to the keeper in the opposite direction to that resulting from the galvanic current, there would be no electrical effect produced, supposing the electro-magnets were absolutely free of magnetism; but by inserting a battery of a single cell in the circuit, a certain magnetic condition would be set up, causing similar electro-magnetic poles to be forcibly severed, alternately, the rotation being contrary in direction to that which would be produced by the exciting current.

Instead of employing a battery to commence the accumulative action of the machine, it sufficed to touch the soft iron bars employed with a permanent magnet, or to dip the former into a position parallel to the magnetic axis of the earth, in order to produce the same phenomenon as before. Practically it was not even necessary to give any external impulse upon restarting the machine, the residuary magnetism of the electro-magnetic arrangements employed being found sufficient for that purpose.

The mechanical arrangement best suited for the production of these currents was that originally proposed by Dr. Werner Siemens in 1857, consisting of a cylindrical keeper, hollowed at two sides, for the reception of insulated wire, wound longitudinally, which was made to rotate between the poles of a series of permanent magnets, which latter were at present replaced by electro-magnets.

On imparting rotation to the armature of such an arrangement, the mechanical resistance was found to increase rapidly, to such an extent that either the driving strap commenced to slip, or the insulated wires constituting the coils were heated to the extent of igniting their insulating silk covering. It was thus shown to be possible to produce, mechanically, the most powerful electrical or calorific effects, without the aid of steel magnets, which latter were open to the practicial objection of losing their permanent magnetism in use.

The reading of this paper was followed by one by Professor Wheatstone, F.R.S., "On the Augmentation of the Power of a Magnet, by the Reaction thereon of Currents induced by the Magnet itself." In this magneto-electric machine the core of the electro-magnet is formed of a plate of soft iron, 15 inches in length, and $\frac{1}{2}$ inch in breadth, bent at the middle of its length into a horseshoe. Round it are coiled, in the direction of its breadth, 640 feet of insulated copper wire, $\frac{1}{15}$th inch in diameter. The armature consists of a rotating cylinder of soft iron, 8$\frac{1}{2}$ inches in length, grooved at two opposite sides, so as to allow the wire to be coiled upon it longitudinally; the length of the wire thus coiled is 86 feet, and its diameter is the same as that of the electro-magnetic coil.

If now the wires of the two circuits be so joined as to form a single circuit in which the currents generated, by the armature, after being changed to the same direction, act so as to increase the existing polarity of the electro-magnet, the force required to move the machine will be very great, showing a great increase of magnetic power in the horseshoe; and the existence of an energetic current in the wire is shown by its action on a galvanometer, by its heating four inches of platinum wire ·0067 inch diameter, by its making a powerful electro-magnet, by its decomposing water, and by other tests.

The explanation of these effects is as follows:—The electro-magnet always retains a slight residual magnetism, and is therefore in the condition of a weak permanent magnet. The motion of the armature occasions feeble currents, in alternate directions, in the coils thereof, which, after being reduced to the same direction, pass into the coil of the electro-magnet in such a manner as to increase the magnetism of the iron core; the magnet having thus received an accession of strength, produces in its turn more energetic currents in the coil of the armature, and these alternate actions continue until a maximum is obtained, depending on the rapidity of the motion and the capacity of the electro-magnet.

It is easy to prove that the residual magnetism of the electro-magnet is the determining cause of these powerful effects. For this purpose it is sufficient to pass a current from a voltaic battery, a magneto-electric machine, or any other rheomotor, into the coil of the electro-magnet, in either direction; and it will invariably be found that the direction of the current, however powerful it may eventually become, is in accordance with the polarity of the magnetism impressed on the iron core.

A very remarkable increase of all the effects is observed when a cross wire is placed so as to divert a great portion of the current from the electro-magnet. The four inches of platinum wire, instead of flashing into redness, and then disappearing, remain permanently ignited. The inductorium, which before gave no spark, now gave one half-an-inch in length. Water is more abundantly decomposed, and all the other effects are similarly increased.

A certain amount of resistance in the cross wire is necessary to produce the maximum effect. If the resistance be too small, the electro-magnet does not acquire sufficient magnetism; and if it be too great, though the magnetism become stronger, the increase of resistance more than counterbalances its effect.

But the effects already described are far inferior to those obtained by causing them to take place in the cross wire itself. With the same application of force, 7 inches of platinum wire were made red hot, and sparks were elicited in the inductorium 2½ inches in length. The force of two men was employed in these, as well as in the other experiments. When the interruptor of the primary coil was fixed, the machine was much easier to move than when it acted; for when the interruptor acted at each moment of interruption, the cross wire being, as it were, removed, the whole of the current passed through the electro-magnet, and consequently a greater amount of magnetic energy was excited, while at the intervals during which the cross wire was complete the current passed mainly through the primary coil.

There is an evident analogy between the augmentation of the power of a weak magnet, by means of an inductive action produced by itself, and that accumulation of power shown in the static electric machines of Holtzman and others, which have recently excited considerable attention, in which a very small quantity of electricity, directly excited, is, by a series of inductive actions, augmented, so as to equal, and even exceed, the effects of the most powerful machines of the ordinary construction.

The magnetic polarity of rifles is a subject to which Mr. Spiller, of the Royal Arsenal, Woolwich, has lately drawn attention. He finds that all the long Enfield barrels in the possession of the volunteers of his company exhibit magnetic polarity, as the result of the violent and repeated concussions attending their discharge, in a direction parallel to the magnetic meridian. The Royal Arsenal range runs nearly north and south, and the rifles, when in use, are always pointed either due north or a few degrees towards the west; in fact, nearly in the direction indicated by a compass needle,—so that the repeated shocks brought about by the explosion of the powder may be considered equivalent to so many hard blows from a hammer, which are known to have a similar effect. The magnetic character appears to be permanent, which would not be the case if the gunbarrels were of the softest description of malleable iron; and the region of the breech is, in every instance, possessed of north polarity, since it strongly attracts the south pole of the compass needle. These effects would probably not be noticed at all, or only to an inferior degree, in arms ordinarily fired, in directions east and west; and it would be imagined that by reversing the usual practice, if it were possible, and firing towards the south, the indications of polarity would be changed.

The foregoing observation seems to have a parallel in the remarkable instance of the polarity of Her Majesty's ironclad 'Northumberland,' built last year at Millwall. This vessel was placed due north and south during her construction, and the repeated vibrations to which she was subject whilst in that position induced a condition of polarity which demanded a subsequent operation for the purpose of demagnetizing her. No such practical inconvenience arose in the case of the iron steamship 'Great Eastern,' which was built in the same yard, but in a position at right angles to the former, or nearly due east and west.

M. Roullion proposes a new battery based upon some observations he has made on the action of aqua regia on silver. A mixture consisting of two-thirds hydrochloric and one-third nitric, or three-fifths hydrochloric and two-fifths nitric acids will easily dissolve gold and platinum, but will only superficially attack pure unalloyed silver; a superficial chloride being formed, which protects the rest of the silver like an impermeable varnish, however long it may remain in the aqua regia. If copper be present, the metal is attacked. M. Roullion has utilized this fact to make a new battery, in which pure silver in aqua regia replaces the platinum or carbon in the nitric acid of a Grove's or Bunsen's cell. He says that after several months' use, the silver has not sensibly diminished in volume, and no chloride of silver has been found in the porous cell. He considers this battery to be more constant than Bunsen's battery.

The gas battery of Mr. Grove has received some attention from M. J. M. Gougoin. He arrives at conclusions in perfect conformity with those of M. Schönbein. Mr. Grove supposes that it is indispensable for each of the electrodes of platinum of his gas-couple to be simultaneously in contact with one of the gases and with the liquid placed underneath. M Gougoin states, on the contrary, that the action of the platinum does not take place except on the gases already below, and that the gas receivers should only be considered as reservoirs to maintain in a state of saturation the solutions they cover. The electro-motive force of the gas-couple varies curiously with the state of the platinum wire. Its action is increased, as M. Matteucci remarked, by heating the elements in the flame of a spirit-lamp some instants before employing it. In the most favourable conditions, the electro-motive force of the gas-couple constructed with platinum wires not platinized scarcely exceeds 155, taking as unity the electro-motive force of a thermo-electric couple of bismuth and copper, the two solderings of which are maintained at the temperature of 0° and 100° C. The electro-motive force of a Daniell's couple is represented by 193, and that of Volta by 178, at the moment of being set to work.

An automatic electro-chemical method of electric transmission of despatches has been invented by MM. J. Vavin and G. Fribourg. It consists in the distribution of the current through as many short and isolated small wires as there are signals to be transmitted, whilst employing only one wire on the main line. Each of these small isolated wires communicates on the one hand with a metallic plate of a particular form fixed in gutta-percha, and on the other hand with a metallic division of a disc, which is equally formed of an insulating substance. A group of eleven of these small laminæ form a sort of character which will give all the letters of the alphabet by the suppression of certain portions of the fundamental form. Now, supposing rows of these compound characters to be placed on a sheet of prepared paper of a metallic nature, the words of the telegram to be sent are written on them with isolating ink, leaving the other parts of the small "stereotyped" blocks untouched. The consequence is that the current is intercepted at every point touched by the ink, and a letter is imprinted on the prepared paper at the other end of the line where the telegram is to be received. The process by which all these several currents are sent along the one main wire and then made to separate at the end and pass into their respective small wires, is not at all clear in the authors' description.

Lightning-protectors for telegraphic lines have been in use for many years; an improvement lately brought out consists of two smooth brass plates from 3·87 to 4·65 square inches, placed one above the other, and separated by a sheet of paper; one of the metal plates is in connection with the line, the other communicates with the earth. As soon as a rather strong tension occurs on the line, sparks pass from one plate to the other, perforating the paper, and the electricity passes into the earth instead of along the line, disarranging the instruments. M. Guillemin proposes to replace the paper by a very thin layer of mica. The mica is a better insulator; it does not absorb damp; it cannot produce carbon, since it is of a mineral character; moreover, its ready cleavage allows of its being split into plates thinner than a sheet of paper. The administration of the French telegraphic lines purposes placing very shortly a great number of these lightning protectors in places subject to most frequent attack by the electric fluid of the atmosphere.

The lecture theatre of the Royal Institution was crowded on Friday evening, the 15th of February, to hear a discourse, by Mr. Cromwell Varley, "On the Atlantic Telegraph." On the table there were displayed coils of the cable successfully laid last year, and of the cable which had been picked up from a depth of two miles, having lain at the bottom of the sea for twelve months. Mr. Varley did not enter into the consideration of the mechanical construction of the cable, nor of the plan of laying it down, but confined himself to the scientific part of the subject, and to the explanation of the difficulties which arise in attempting to transmit electric signals through great lengths of submerged insulated wire. By means of his artificial cables he demonstrated, for the first time in public, how the electric waves travel through. He also showed what were the limits imposed by nature to rapid signalling.

A telegraphic cable is a long Leyden jar, one end of which is attached to the earth, whilst the other is attached to a source of electricity each time a signal is to be produced. If the cable be connected to a battery for a long time, the strength of the charge in the different parts of the cable will be nothing at the end next the earth, and equal to the full power of the battery at the other end.

The lecturer had diagrams showing the rate at which the strength of the electric currents augmented or died away at the distant end of the cable, when a battery was applied or removed from the other end. From these diagrams and experiments it was shown that to get rapid signals the receiving instrument must be very sensitive, and the moment a current begins to appear at the distant end the rest of the electric wave must be neutralized, to permit a second signal to follow. This was illustrated by an artificial line equal to a cable 13,000 miles long. This line was divided into eleven sections, and ten reflecting galvanometers were inserted at equal distances along it. To familiarize the audience with the relative position of the galvanometers, Mr. Varley called No. 1, Gibraltar; No. 2, Malta; 3, Suez; 4, Aden; 5, Bombay; 6, Calcutta; 7, Rangoon; 8, Singapore; 9, Java; and 10, Australia.

A long telegraphic cable is a long Leyden jar of great resistance—so great that, instead of electrical charges rushing in and out almost instantaneously, as is the case with ordinary Leyden jars, an appreciable time is necessary to convey a decided charge through so long a conductor to the distant end. The artificial representative consisted of eleven resistances and ten immense condensers, or Leyden jars, connected between the resistances and the earth. By moving a handle the condenser could be applied on or removed from, these junctions.

On depressing an ordinary commutation key, the cable was removed from its connection with the earth, and a positive current allowed to flow into the line. On depressing a second key, a negative current rushed in; whilst when both the keys were at rest, the cable was simply connected with the earth. The ten reflecting galvanometers were placed one above the other, and a bundle of rays from the electric lamp was thrown upon the ten mirrors, each of which reflected a little sun-like spot upon a large white screen, forming, when no current was passing through the cable, a straight vertical line of luminous points. On pressing the right-hand or positive key, the upper spot, which was named Gibraltar, almost immediately responded; and when it had travelled about thirteen inches over the screen, the second spot, Malta, began visibly to move; the third spot, Suez, following later still. It was, however, fifteen or sixteen seconds before any decided motion or current was noticed at the Australian end of the line. After the lapse of a minute, a powerful current was rushing out at the Australian end. The English end was then removed from the battery and connected with the earth, and quickly after the Gibraltar spot rushed across to the other side of the screen, indicating the rushing back of a powerful current to the earth. This was followed shortly afterwards by Malta, Suez, and Aden. Bombay came only as far as the zero line. The currents in the different parts of the cable were flowing out at each end, leaving Bombay neutral. It was some minutes before the cable discharged itself sufficiently to allow the ten spots to come near enough to the zero line to admit of a second experiment.

In 1863–64 Mr. Varley found, by experiments on his artificial line, that by using a succession of four or five currents, all of the same strength but varying in direction, greater rapidity could be secured. For example:—First, a positive current, followed by a negative of longer duration; followed again by a positive current of much less duration; then a shorter negative current; and that again by a very short positive current, produced a succession of positive and negative waves throughout the line: the result of all of which was at the Australian end one very small positive wave perfectly distinct, the rest of the line being left almost immediately entirely free from all traces of electricity, ready for the instant production of a second signal.

This operation of discharging has been expedited to such an extent by means of the instrument known as the "curb key," that the great wave can be arrested at the distant end of the cable before it has arrived at $\frac{1}{100}$ of its proper height, and the line left clear for another signal almost immediately after. This was illustrated by the Australian line.

The lecturer then showed his invention for preventing the disturbance arising from earth-currents, and for expediting the signals through the cable, which did not record the strength of the current, but "the rate of increment and decrement of potential."

He placed a reflecting galvanometer between the distant, or "Newfoundland," end of the cable and the earth (this being the usual mode of connecting telegraph instruments), and also a second one with a "condenser" between it and the earth. At the English end there was an apparatus which produced currents through the cable similar to those produced on the telegraph circuits by the Aurora Borealis and other causes. These experiments were very conclusive; the slow but large wave of the earth-current was seen to produce scarcely any action upon the galvanometer with the condenser, while the ordinary one was seen running 20 feet on either side of the scale in consequence of the earth-currents.

The small waves on the back of the great swell of the earth-currents were, however, perfectly disentangled, by this simple contrivance, from the great slow-rising wave, and the signals were perfectly legible on the one instrument, while illegible on the other, whose image ran wildly over the wall of the Institution. In addition, the signals were transmitted more rapidly and clearly by this arrangement.

In concluding, Mr. Varley remarked that it was upon the data furnished by this artificial cable that he had designed the present Atlantic cable, and that without it he could not then have guaranteed eight words a minute without a core whose conductor and insulator were each 60 per cent. greater than the present, which consisted of 300 lbs. of copper and 400 lbs. of gutta-percha to the mile; and he added that it was at least some reward for the years of arduous labour he had had in connection with this great enterprise, to find that everything he had predicted as to the capabilities of the cables had been entirely verified.

12. ZOOLOGY, ANIMAL MORPHOLOGY, AND PHYSIOLOGY.

MORPHOLOGY.—*The Structure of the Retina.*—That eminent observer, Professor Max Schultze, has recently published in his 'Archiv f. Mikroskop f. Anatomie,' a memoir on the Retina, which occupies more than 100 pages, and is illustrated with eight quarto plates, forming by far the most complete and clear exposition of the structure of this organ which has yet been published. Amongst the important new facts adduced by Professor Schultze is the observation that in Mammalia a very remarkable, and, as it would seem, hitherto unnoticed diversity, exists, with regard to the distribution of "rods" and "cones." Whilst most of our larger domestic animals, especially the sheep, ox, pig, horse, and dog, present an arrangement of those elements resembling that which is observed in the human subject and in apes (except, of course, in the absence of the *macula lutea*), the cones, according to the author's observations, are entirely wanting in bats, the hedgehog, mole, mouse, and guinea-pig. A sort of intermediate condition is met with in the cat, rabbit, and rat, in which animals are found either very slender true "cones," as in the cat, or merely indications of them, as in the rabbit. The development of the retina and the probable functions of the rods and cones are fully discussed. The great value of Professor Schultze's paper lies in the fact that he has not only made many new observations, but has most carefully tested the conclusions and statements of previous writers; and further, has spared no pains in illustrating his text with some of the most beautiful lithographs yet published. In his researches Professor Schultze has experienced the greatest advantage from the use of a solution of hyperosmic acid, $Os\ O_4$, which colours nerve-tissue black, without producing much effect on connective and fibrous tissue. We most strongly urge upon microscopists the importance of making further trial of so valuable a reagent.

Entozoa of Man and Domestic Animals in Iceland.—M. H. Krabbe has made some valuable investigations on this matter, in pursuance of a commission from the Danish Government. He has ascertained various important facts with regard to the distribution of species of *Tænia*, *Bothriocephalus*, &c., and has observed some new forms. He is quite convinced that the frequency of *T. marginata*, *cœnurus*, and *echinococcus* in Iceland is owing to the very vast number of sheep which the inhabitants possess, and the large number of dogs which they use in herding them. It appears that in Iceland there are for every hundred of inhabitants *four times* the number of cattle which there is for every hundred inhabitants in Prussia. At the same time he maintains that the frequency of the fearful malady caused by *echinococcus* is much exaggerated—instead of one-seventh, only one-fiftieth of the population is affected, which is quite terrible enough.

PHYSIOLOGY.—*Impregnation of the Ovum* versus *Nourishment of the Larva.*—Dr. Herman Landois has recently communicated some important observations on this subject to the French Academy. It is generally believed, in accordance with the observations of MM. Dziergon and von Siebold, that the worker-bees are born from eggs fecundated by the queen by means of the sperm of her receptaculum seminis, whilst drone-bees come from non-fecundated eggs. M. von Siebold maintained, in particular, that the demonstrated existence of spermatozooids in the eggs contained in the "cells" appropriated to worker-bees, and their non-existence in the eggs of drone-cells, sufficiently proves that in bees the formation of the sexes depends upon fecundation. It is, however, well known that the "cells" of drone-bees are not in any way identical with those from which "worker-bees" emerge, and that the food provided for the larvæ of the one is not the same as for the larvæ of the other. This led Dr. Landois to speculate as to whether it might not be possible, by placing the egg from the drone-cell into the worker-cell, and *vice versâ*, to produce drones from the worker-eggs and workers from the drone-eggs. This he accordingly tried with great care, failing at first on account of the exceeding delicacy of the eggs experimented on, but finally meeting with most complete success. By simply changing the "cell" of an egg, he produced a drone or a worker-bee at pleasure. These observations have a most important bearing on the law of sexual development, not only in insects, but all animals. We had been taught to believe, from Siebold's experiments, that the "network of causes" was so arranged that a queen-bee, if unimpregnated (as might result from paucity of drones), produced from her eggs nothing but drones, in order that the next generation might not be wanting in that "vigour" which is supposed to be the final cause of sexual reproduction. If, however, Dr. Landois' experiments are true, this view must be considerably modified, for the nutrition of the larval animal is shown to regulate the phenomenon. Dr. Landois has entered into some philosophical generalizations on reproduction in the conclusion of his paper, which is not, however, yet published in full.

Action of Nitrous Oxide on the Human System.—It appears that the protoxide of nitrogen has been used in Germany and France as a means of producing anæsthesia in surgical operations. M. L. Hermann addresses a letter to the French Academy on the subject, seriously urging all operators to make themselves acquainted with its properties before using it as an anæsthetic. He has made several experiments with it himself, and has found that, when respired in a pure condition, protoxide of nitrogen is dangerous; for, besides loss of sensibility, asphyxia is produced, which may kill the patient; administered in a state of mixture with oxygen, the only plan which, in M. Hermann's opinion, would not be simply criminal on the part of the operator, it constitutes a very feeble anæsthetic, from which recovery is rapid. Its use has already produced most serious disasters in Germany.

The Wave-lengths of the Transmission of Muscular and Nervous Action.—In a late Chronicle we noticed Dr. Marey's instrument, the Myograph, with which he has been able to make observations on the *muscular susurrus*—that is, the separate vibrations which, when succeeding each other sufficiently rapidly, constitute a muscular contraction. Dr. Haughton, of Dublin, has been comparing the rate of these vibrations, and their lengths, with those caused by nerve action. Wollaston fixed the muscular susurrus, or agitation sufficient to produce contraction, at from 20 to 30 per second; Dr. Collongues, of Paris, at 35; and Dr. Haughton, as also Helmholtz, at 32 in a second. Dr. Haughton, from the so-called *tinnitus aurium*, which is caused by the action of the nerves, fixes the rate of nerve vibration at 1,024 in a second. From these data it follows that the rate of nerve action is from 29 to 32 times as fast as the rate of muscular action. Dr. Schelske's experiments have shown that the velocity of wave-transmission of sensation in the living body of man is 97 feet per second; and the experiments of Professor Aebe, of Berne, show that the velocity of wave-transmission of muscular contraction in frogs is 3 feet per second. The wave-transmission in nerves is therefore 32 times as fast (or 29 times, if Helmholtz's determination of 88 feet per second be taken) as the wave-transmission in muscles. It appears, from these facts taken together, that the velocity of the wave varies inversely as the rate of vibration when muscles and nerves are compared, and consequently the length of the wave is constant: hence the wave-length of muscular and nervous action, for both lies between 1·125 and 1·225 inch. Dr. Haughton considers that important consequences ought to follow from this deduction, if true. Many advantages may flow from identity in wave-length of the muscular and nervous force, and the consequent identity of nodes, notwithstanding the very different velocities with which wave-pulses are propagated along them. The data upon which these calculations are made admit, of course, of great extension. Since, as Dr. Marey has shown, the muscular susurrus in the frog may be only 4 per second, and in some birds 75 per second, it would be as well that all the data should be taken from one animal or class of animals, if the calculation is to be a sound one. It is an assumption, the truth of which ought to be proven, that the rate of transmission of muscular force is the same in all animals.

The Origin of Muscular Power.—The view held by Liebig, and till lately implicitly received as true, that muscular power is due to muscle-oxidation, has been, during the last few months, rudely shaken. Professors Fick and Wislicenus, in an ascent of the Faulhorn in Switzerland, found that the amount of measured work performed in the ascent exceeded by more than three-fourths the amount which it would be theoretically possible to realize from the maximum amount of muscle-oxidation, indicated by the total quantity of nitrogen in the urine. These two observers had, however, to content themselves with the *theoretically* possible force, and hence there was an experimental gap in their reasoning. This has been supplied by Professor Frankland; he has made an extensive series of experiments on the oxidation of muscle and urea in oxygen, and has made a calorimetrical determination of the actual energy evolved by the combustion of these bodies. His experiments are recorded in full in a late number of the 'Philosophical Magazine,' and the various steps of the very intricate process through which he has successfully carried his observations fully described. Since the oxidation of muscle-tissue in the body has, as one of its products, urea, it is necessary to make allowance for the potential energy of this urea in applying the results of the complete oxidation of muscular tissue to the question at issue. It is also necessary to make allowance for the fact that *all* the energy developed in the body cannot be made to appear as *external* work. Helmholtz estimates that not more than one-fifth of the actual energy developed can be made to appear as external work; while Heidenhain, under favourable circumstances, allows one-half. Taking this last estimate, Dr. Frankland finds that only one-fifth of the work done by the two professors could be accounted for by the oxidation of their muscular tissue, as indicated by the urine. He further reviews the results of Dr. E. Smith's, Dr. Haughton's, and Dr. Playfair's experiments, applying his determination of the "mechanical equivalent" of muscle-oxidation to their results.

The work done in the body is then evidently due merely to the oxidation of the food held in the blood. The chief use of nitrogenous food is to build up muscle-tissue, which, like the cylinder and piston of the steam-engine, does not contribute to the work performed by its oxidation, but is the means of converting chemical and thermal modes of force into motion; the force being really obtained by the oxidation of principally carbonaceous, but to some extent also nitrogenous, foods contained in the blood.

The Value of Nitrogenous and Carbonaceous Foods.—This question, which is one obviously resulting from the conclusions arrived at by Fick and Wislicenus, has been examined experimentally by Professor Pettenkoffer, and more recently also by Dr. Parkes. Professor Frankland has also determined the mechanical value of these forms of food, by experiments on their oxidation. Professors Fick and Wislicenus ate carbonaceous, but no nitrogenous food during their ascent, and hence concluded that all the power not derived from muscle-oxidation was due to the oxidation of the carbonaceous foods. Pettenkoffer's experiments, which are most conclusive as regards the whole question of the source of muscular force, were made by means of a most elaborately constructed chamber, in which a man was placed, and all his excreta, gaseous, liquid, and solid, examined. Dr. Parkes experimented very carefully on two soldiers at Netley Hospital, and communicated his results to the Royal Society at the beginning of this year. Both these observers have fully established that mere force *can* be supplied by carbonaceous food alone—that nitrogenous food is necessary to build up the worn muscles, and that nitrogenous food, by its *direct* oxidation, is also efficient in supplying force, and perhaps presents certain advantages over carbonaceous food in its use, either from the facility of its oxidation, or by a catalytic action on the carbonaceous foods with which it is generally taken. The views we have been briefly noticing are of too great importance to admit of their due appreciation from the perusal of so few lines, and we must therefore refer the reader to the original memoirs in which they are advanced. It should be mentioned that Voit, a chemist of Munich, appears to have anticipated these results by some few years; his speculations were, however, cast into obscurity by the proximity of the over-shadowing genius whose assertions they controverted.

MISCELLANEOUS.—Dr. Ernst Haeckel has just published two very remarkable volumes on the philosophy of organic forms, entitled 'The Morphology of Organisms.' He takes much the same line of argument as Mr. Herbert Spencer in his 'Principles of Biology;' but he enters into greater detail, and develops his views further than the English writer. This book, like that of Mr. Spencer, may be regarded as an extension of Mr. Darwin's generalizations, and is, as far as we have been able to observe, a work destined to exert considerable influence in the world of physio-philosophers. We have also to notice a little *brochure* on 'Spontaneous Generation and the Development of Infusorial Life,' forwarded to us by Mr. Jabez Hogg. The author has told the story of Heterogenesis (which, by the way, is getting rather old) in a clear and plain manner, drawing attention more particularly to the question of the successive appearance of forms of Infusoria in an infusion, as studied by Mr. Samuelson, Balbiani, and others. There are one or two inaccuracies in nomenclature, such as *Acitena; Vor-*

ticellæ are confused with *Rotifers*, &c., and a misapprehension is evident of recent observations on the refractive power of fungus-spores, as seen in the "blue-mist;" these errors would be serious in a scientific publication, but do not really affect the value of a popular essay.

PROCEEDINGS OF THE ZOOLOGICAL SOCIETY.

At the meetings of this session there have been numerous valuable papers read, chiefly devoted to the description of new forms or rearrangement of previously known animals. The following papers relate to the Mammalia:—Mr. W. H. Flower, F.R.S., has brought forward a memoir on the skeleton of *Inia Geoffroyensis*, and on the skull of *Pontoporia Blainvillii*, in which he made some remarks on the systematic position of these animals in the order Cetacea. Mr. Flower has recently been devoting much time and attention to the study of this order of mammals, as his work published last year by the Ray Society testifies. Dr. W. Peters, of Berlin, made a communication on some Mammalia collected by Captain Bevan in Bermuda, and on a collection of bats from Trinidad. Mr. Gerard Krefft, of Sydney, has described two new species of Dasyuridæ, which he proposes to call *Podabrus Michelli* and *Chætocercus cristicauda*. Mr. Robert Swinhoe, H.M. consul at Amoy, China, has forwarded a new monkey to the menagerie, which he proposes to call *Inuus Sanctijohannis*. Mr. St. George Mivart, in continuance of his researches on the Primates, has communicated a paper on the appendicular skeleton of the Ourang-Outang, in which he has entered very minutely into the osseous characters of that animal.

Mr. P. L. Sclater described a new species of Ratel, recently added to the Society's menagerie, which he proposed to call *Mellivora leuconota*. A letter has been received from Mr. E. Bartlett, now engaged in exploring the fauna of Peru, in which he mentions the discovery of a remarkable species of spider-monkey, supposed to be new to science. The death of the sea-bear (*Otaria*) has afforded an opportunity for the examination and dissection of its viscera, which we believe has never yet been possible. The Society's Prosector, Dr. J. Murie, has been occupied in this task, and some important results may be expected from his investigations.

In Birds, we have numerous new species, or rarer forms, described by Mr. Sclater, and other ornithologists. Dr. Murie has been making some investigations with regard to the *Cygnus buccinator*, and the new *Cygnus Passmori* of Professor Hincks, which he considers to be nothing more than a variety of the former.

Dr. Gray and Dr. Günther have described a few new reptiles. The former characterizes a Geckoid lizard from Ceylon, which he proposes to call *Gecconella punctata*.

The Fishes of Central America, among which are some very remarkable forms, and various new fishes in the British Museum, have formed the subjects of communications from Dr. Günther.

Mr. A. G. Butler, who is the rising Lepidopterist of the day, has described several new forms of these insects at various meetings of the Society, illustrated by most finished drawings from his own pencil. One of his most complete papers is entitled "A Monograph of the Genus *Euptychia*, a numerous race of Butterflies belonging to the family Satyridæ, with Descriptions of Sixty Species new to Science, and Notes on their Affinities." The Coleoptera of the island of Penang have formed the subject of communications from Mr. F. Pascoe, while Mr. F. Moore has contributed a monograph on the Lepidoptera of Bengal.

The Mollusca collected by Mr. E. Bartlett on the Upper Amazons and in Eastern Peru, have been described by Mr. Henry Adams. The genus Opisthostoma, of which a new species has been discovered at Bombay, has been discussed by Mr. Blandford; and several new Australian land-shells have been described by Dr. J. Cox; and thirty-two new marine species of Mollusca from the same part of the world have been described by Mr. Angus.

The extraordinary Glass-Rope animal has been the subject of great controversy between Dr. J. E. Gray and Dr. Bowerbank, the former maintaining that it is a coral, the latter that it is a sponge. It appears that there are three views current with regard to this marine organism. It is regarded as a coral, having a sponge parasitic upon it; or as a sponge, having a coral parasitic upon it; or as altogether a sponge, there being no parasite in the case. Dr. Gray is of the first opinion, Professor Max Schultze of the second, and Dr. Bowerbank of the third. Dr. Bowerbank's position is clearly untenable, and the question really lies between the views of Dr. Gray and Professor Schultze. Dr. Gray has described and exhibited a specimen which was said to come from the coast of Portugal, the other known specimens all being obtained from Japan. It appears very doubtful as to whether this Lusitanian Hyalonema is not an imposition played off by the sailor who said that he dredged it up; this is the view taken by Professor Schultze, but Dr. Gray believes firmly in the species.

THE PUBLIC HEALTH.

During the past three months the public has had an opportunity of seeing what can be done by the "Sanitary Act of 1866." Powers are there given to local bodies to act with much more energy than under any previous sanitary enactment, but as yet little benefit has been recorded as the result of these powers. The "permissive" character of all our previous legislation is still the bane of this Act, and our local authorities turn a deaf ear to the allurements presented by the government. If all our criminal legislation were put upon the permissive basis, there is little doubt that in some parishes the vestries would not take the trouble to prosecute those who were guilty of the crime of murder. This Act nowhere says it shall be unlawful for a man to keep his house and premises in such a state that he may kill his neighbours, but it gives to the local authorities power, if they think fit, so to prosecute and punish him. The mischief is the local authorities do not punish, nor act even, if they see a man poisoning and killing his neighbours by his dirty and filthy economy. This Act gives the Home Secretary power to compel vestries to act upon cases where manifest evils result from allowing nuisances injurious to health to exist, but the Home Secretary is as chary as a vestryman about taking action in particular cases, and from this cause at present little has been done.

The 35th clause of this Act has, however, excited some attention, and in London, Liverpool, and other towns there has been some discussion as to how it may be carried out. This clause gives power to the vestries and local boards to frame regulations for the conduct of all houses let out in lodgings, or where more than one family is residing and paying rent to a common landlord. This provision is intended to meet the necessity of a large proportion of the population of our large towns, who are merely lodgers and have no power of providing against various nuisances injurious to health, for which alone the landlord is responsible. Under the provisions of this Act, the nuisance authority is empowered to make regulations for the following matters, that is to say:—1. For fixing the number of persons who may occupy a house or part of a house which is let in lodgings or occupied by mechanics of more than one family. 2. For the registration of houses thus let or occupied in lodgings. 3. For the inspection of such houses and the keeping the same in a cleanly or wholesome state. 4. For enforcing therein the provision of privy accommodation and other appliances and means of cleanliness in proportion to the number of lodgers and occupiers, and the cleaning and ventilation of the common passages and staircases. 5. For the cleaning and lime-whiting at stated times of such passages, &c.

This clause gives power to vestries to take into their own hands the redress of sanitary grievances. Manifold and obvious as are the nuisances to be thus got rid of, it is astonishing with what indifference this Act has been regarded. In the metropolis the first parish to take advantage of the law was that of St. Giles, and a series of excellent regulations, framed upon the recommendations of the Privy Council as to the carrying out of the above clause, were drawn up by their intelligent medical officer of health, Dr. Buchanan, and received the sanction of the Home Secretary. The publication of these regulations was followed by applications from the vestries of Chelsea and Poplar, who have also had their regulations confirmed by the Home Secretary. The parish of St. James, Westminster, has also made application for the confirmation by the Home Secretary of a series of regulations. The latter parish was anxious to obtain power to regulate the accommodation afforded by the numerous establishments in that parish for milliners, tailors, apprentices, and others. The officers of the Privy Council, however, were of opinion that the clauses of the Sanitary Act did not refer to persons thus situated. This is much to be regretted, as it is very evident from what has transpired that persons employed in the large establishments of London are obliged to submit to accommodation in workshops and sleeping-rooms totally unfitted to secure health and life. In the parish of St. James, Westminster, the great mortality from consumption is one of the most conspicuous features of its death returns, and there can be little doubt that this arises from the defective accommodation provided for a large portion of its population.

One of the most conspicuous features of the above regulations is the attempt to define the quantity of cubical space that shall be required in the lodging-rooms of the metropolitan population. In St. Giles's, a space of not less than 400 cubic feet is required for each person. In Chelsea, the minimum space for a room used for both living and sleeping is 350 cubic feet, and for sleeping alone is 300 cubic feet. In Poplar, the space required for both living and sleeping is 400 cubic feet, and 300 for sleeping alone. In these cases two children under ten years of age count as one adult, and should these regulations thus sanctioned by the State be carried out with vigour, there is no doubt of the benefit that must accrue. But when it is seen that only four out of the fifty districts, into which London is divided for sanitary purposes, are willing to adopt these necessary regulations, it is much to be feared that the same neglect of the health and lives of the community which have hitherto characterized London vestries will still continue. It is little creditable to the large and wealthy communities of St. Marylebone, Paddington, St. Pancras, Islington, and the parishes of the East of London generally, that they have not stirred in this matter more vigorously.

The clauses 27 and 28 of the Sanitary Act have already been acted on in London with great benefit. By these clauses the medical officer of health is enabled to remove a dead body, where it lies in the midst of the living, to the parish dead-house previous to interment. The coroner has also the same power to order the removal of bodies to convenient places for the purpose of post-mortem examinations. In Central Middlesex this plan has now been carried out in many instances, and has met with little or no opposition from the relatives of the dead, and hence the saving of much inconvenience to the medical witnesses and of time to the juries. The same clauses of the Sanitary Act, 1866, give power to the vestries to build mortuaries, or dead-houses, for the reception of the dead. If these places were built independent of the workhouse, and fitted up with regard to the solemn feelings inspired by death, and made architecturally pleasing to the eye, there is little doubt that large numbers even of the wealthier classes would have recourse to them for the purpose of depositing their dead before burial. Such places should be sufficiently large to receive all the dead of the district in which they exist, and should have a room attached for post-mortem examinations, and another larger room in which the coroner and his jury might assemble. The place should be taken care of by persons who should keep everything scrupulously clean, and disinfectants should be applied to the dead bodies in all cases where the slightest effluvium is emitted. Such places might easily be erected on the shut-up burial-grounds throughout London, and would be alike beneficial to public health and creditable to our civilization.

The prospects of Sanitary Legislation for 1867 are almost entirely confined to the passing of the Metropolitan Poor Act of 1867. The progress, however, of this Bill has been so satisfactory that there is now every reason to hope that it will speedily become law. It has long been apparent that the present constitution of our workhouses and their management by the Guardians of the Poor, however desirous the latter might be of doing their duty by the poor, were open to great scandal. The principal object of the Guardians was to keep down the expenditure of the rates, and as long as this object was attained they cared little for the welfare of the poor. Although subject to the control of the Poor Law Board, that body has always been kept at arm's length by the Guardians, and it was only the investigations of the coroner's court penetrating the interior of the workhouses in London, that at last brought to light the mismanagement and neglect that characterized the arrangements in metropolitan workhouses. The object of Mr. Gathorne Hardy's Metropolitan Poor Bill is to take out of the hands of the present Boards of Guardians the management of the sick, infirm, aged, and insane poor, and place them in institutions under the control of managers, partly appointed by the parishes and partly by the Poor Law Board. London, for the purposes of this Act, is to be divided into districts, in which asylums will be built, having for their especial object the treatment of the sick and insane and the care of the infirm. Dispensaries for the poor are to be erected, where those unable to pay for medical attendance will have a claim for assistance, and other arrangements are to be made which will go far to redeem the character we have lost as a nation for the care and regard of our suffering classes.

The obstruction to business and the danger to life from the overgrown traffic in some of the larger streets of the metropolis, have at last excited the attention of our legislature. Nothing could more forcibly demonstrate the weakness and imperfection of the municipal institutions of London than their utter incapacity to deal with this increasing and universally acknowledged nuisance of the overcrowding of our street traffic. Upwards of two hundred persons have been killed every year for the last five years in the streets of the metropolis, and it has been shown where one person is killed forty are injured, and receive hospital relief.* A large amount of this death and suffering might be prevented by proper legislation, and a Bill has been presented to the House of Lords by the Earl of Belmore for the purpose of procuring legislation on this subject. The principal provision of this Bill is the prohibition of scavenging and the removal of refuse between the hours of ten in the morning and seven in the evening; also, the prohibiting of the unloading and loading of coal, casks, timber, and other heavy goods during the hours of the day. There are also provisions for the removal of snow, and regulations with regard to dogs in order to prevent the extension of hydrophobia. The Bill, as printed, has received considerable alteration in the House of Lords, but still it is to be hoped that a measure will be passed this session of Parliament that will ensure a diminution in the future of the danger which in a single year makes the streets of London more destructive than a great battle.

Although no public action will be taken by the Government on the subject of Water Supply during this session of Parliament, this question must increasingly demand the attention of our legislators. However ample the supply to London may be from the Thames at the present moment, all parties admit that *it is a contaminated supply, is always dirty, sometimes dangerous, and soon must be deficient.* A royal commission, with the Duke of Richmond in the chair, and consisting of Sir John Thwaites, the late Lord Mayor of London, Colonel Harness, and Mr. Prestwich, are now sitting, and examining witnesses on the question of the general supply of water to London. Besides the Thames, there are only two other sources of water for London: water from the chalk, or water from the lakes of Wales and Cumberland. The Corporations of Liverpool and of other towns have placed themselves in relation with the Royal Commission to obtain supplies for their respective towns.

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* See 'Third Annual Report of the Coroner for Central Middlesex.'

At a recent meeting (February 1st, 1867) of the Social Science Association in London, Mr. Bateman read a paper "On a Constant Supply of Water for London," and showed, instead of the present intermittent supply involving the storing in leaden cisterns, that London might have a constant supply without any increase of consumption.

Mr. Thomas Beggs read a paper "On the Water Supply of London," at the Society of Arts on the 22nd of February, 1867. He took a survey of the various plans for affording a further supply of water to London, and defended the present supply from the Thames from the charges brought against it. An interesting discussion followed, in which the whole question of water supply was looked at from various points of view.

Mr. J. B. Denton has published a pamphlet on the question of a water-supply to London, which will probably be noticed in our next Number.

The Social Science Association has had other interesting sanitary questions brought before it during its present session. A most interesting paper was read "On the Social Condition of Merchant Seamen," by Captain Henry Toynbee. He suggested several practical improvements in the treatment of our seamen, and especially pointed out the increase of disease from the neglect of proper diet and accommodation. It is one of the great disgraces of our Mercantile Marine, that life on board their ships is more hazardous to the sailor than living in the most densely populated and ill-ventilated courts of our great cities. It is high time that the shipowners of London, Liverpool, Hull, and Glasgow should see into these things, and wipe this great disgrace from the nation that is never weary of singing till she is hoarse that she "rules the waves." If she would set a better example of how to do it, other nations might listen to the song with more patience.

The result of Captain Toynbee's paper has been the formation of a "Society for the Improvement of Merchant Seamen." We strongly recommend this society to all interested in ships. Its rules, if carried out, will improve the health, strength, and morals of our merchant seamen, render shipwrecks less frequent, and the profits of our mercantile marine much larger.

The department of Public Health of the Social Science Association are about to submit to the President of the Privy Council a memorial on the Public Health Laws, pointing out their diversity and complexity, and consequent feebleness and inactivity. In the conclusion of their memorial to the Government they state—

"1. That the laws of public health require to be revised and consolidated with plain and specific enactments on all sanitary matters.

"2. That permissive enactments are generally taken to be permissions not to act, and that the most useful provisions should be made peremptory.

"3. That the very common deficiency in the administration of the health laws by the local authorities is due to the absence of a central power, which could be appealed to without reference to the courts of law, and could by means of the law compel the local authorities to do their duty."

The permissive character of all our sanitary legislation has long been seen to be the bane of our national existence and the source of a mortality in all our large towns at once alarming and disgraceful. The necessity of bringing the force of public opinion, if not the power of the state, to bear upon our local authorities, who persistently refuse to act upon the powers given them, has led to the formation of a Sanitary Reform League. This body, which held its first meeting at Manchester in February last, already numbers amongst its members many gentlemen in London, Manchester, Liverpool, Leeds, and other towns. It is intended shortly to hold a conference in London, and it is hoped that a body of earnest workers for the welfare of their country will thus be brought together, who will compel an unwilling legislature, and the yet more unwilling vestries of this country, to adopt those measures which are every day becoming more pressingly necessary for the saving of the lives of the people of this country.

As a proof of the necessity of active measures being taken at once, we would refer to a paper in the 'Leeds Mercury' of the 23rd of February last, on the Fever Haunts of Leeds. Without following the author of this paper from court to court, from one den of filth to another, we knew that such things were taking place. It may be very well for the pious church and chapel-going and missionary-society subscribing people of Leeds to say they had no idea such abominations existed. For years Leeds has had its tell-tale, and those who are at a distance have had their eyes upon it. That tell-tale is the bill of mortality, and we find by it that month after month and year after year, and long before its awful mortality attracted the attention of Government, that Leeds was a nest of dirt and filth and neglect. The details of Dr. Hunter's Report, in January, 1866, were so terrible—so unutterably disgusting, that everyone expected that some active measures would have been immediately taken by the inhabitants (for it is sheer nonsense to attribute this neglect to corporations) to remove the evils then exposed. But here at the end of twelve months we find the same sickening account of accumulated filth—of pale-faced, hollow-eyed children—of strong men and women dying of fever; in short, English people giving indications of an existence more degrading than anything Du Chaillu or Livingstone has described of the blacks of Africa. Are there no black-skins or red-skins in the world who will take pity on these poor whites, and send over some missionaries to help them, and try to convert the people of Leeds to Christianity?

We now turn to what is being done in some other towns in the United Kingdom.

Since the remarks were written which appeared in the October number of this Journal in reference to the sanitary condition of Glasgow, that city, in common with other populous places, has had its attack of epidemic cholera and diarrhœa. Compared with the results of that epidemic in some towns, and compared with the population of Glasgow and suburbs, well nigh 500,000, the number of cases and the mortality were small. The visitation, however, has taught some valuable lessons which will not be without effect in the proper quarter. Owing to the existence of a well-qualified sanitary staff, presided over by Dr. W. T. Gairdner and the other medical officers, all of whom were thoroughly alive to the work required of them, and owing, likewise, to the extensive powers vested in the police authorities by the Local Police Act (1866), such provision was made to meet the attack of the conjoined epidemics, that they seem almost to have been frightened away from a city where, on former occasions, they produced dreadful ravages. Very few cases were reported during the months of August and September, and for the three months beginning with October, the following numbers give the total cases and deaths:—

	Cases.	Deaths.
Cholera	45	35
Choleraic Diarrhœa	65	9
Diarrhœa	621	74
Totals	731	118

Besides employing a portion of the Police Fever Hospital formerly spoken of for the patients, a special cholera hospital was erected on Glasgow Green, and amply and suitably furnished at considerable expense. The latter is now closed up—its "occupation 's gone," but the former is in much request for fever patients, typhus having greatly increased, owing probably, in part, to the poverty and wretchedness which great depression in trade has brought about among the poor; indeed, the death rate is now (February) higher than it was during the cholera epidemic. An excellent and complete system of house to house visitation was commenced in the autumn, and is still continued, and to this, as also to the ample supply of Loch Katrine water—probably unsurpassed for quality and quantity either in ancient or modern times—may be attributed the comparative immunity from cholera which Glasgow enjoyed during the recent visitation. *There is no well or pump water used in Glasgow.*

The police authorities, by means of the night part of the force, are still continuing to inspect the houses of less than three apartments, so as to prevent overcrowding, one of the most fruitful causes of epidemic disease. The following table gives the results of the inspection up to, and including, the quarters ending:—

	Houses visited.	Found overcrowded.	Found empty.	Found not overcrowded.
31st October, 1866 . . .	18,208	1,814	328	16,066
31st January, 1867 . . .	20,249	1,679	314	18,256

As regards the sewerage of Glasgow, it may be stated that things are rapidly ripening for action, which must result in measures not yielding in importance to the emptying of the contents of the Highland Loch into the cisterns and baths of the Glasgow citizens, or the scheme for remodelling the streets and other thoroughfares under the City Improvement Act, at an expense of a million and a quarter sterling. The town council was represented in the late Leamington Congress, one of the deputation being Mr. Walter Macfarlane, the manufacturer of the well-known patented sanitary appliances. The Clyde trustees mean action also, as they feel indisposed to submit passively to the great injury which the sewage discharged into the river is effecting upon the shipping, in which most of them are interested; a comprehensive scheme, therefore, for diverting the sewage from the Clyde is not an improbable thing, and seems actually to be "looming" in the near future.

With regard to the health of Liverpool, it is now well known that Mr. Arnold Taylor, of the Local Government Office, visited Liverpool last autumn, to inquire into the system of defecation practised there, and that in his report he was compelled to refer to other causes the high rate of mortality in Liverpool. He drew attention to the imperfect water-supply and the badly constructed houses, as well as to the wretched midden system, and in consequence of his report, the Corporation were requested to discontinue the practice of depositing night-soil on a certain wharf in the heart of the fever district, and to give guarantees that the use of the wharf would be discontinued, except for the shipment of innocuous substances.

The town council, after making haste to comply with a portion of the order, at the instigation of their Health Committee denied the legality of the inquiry, and declined to give the requisite guarantee, lecturing the Home Secretary in a somewhat amusing manner upon his course of proceeding, and saying that the Sanitary Act was not intended for such an influential body of gentlemen as they are. The Sanitary Association of the town, however, supplemented the "reply" of the mayor by further information on the sanitary state of the town, and on the 4th of March, Mr. B. Samuelson, M.P. for Banbury, asked the Home Secretary to publish Mr. Taylor's report, which applies to other towns besides Liverpool, and which the honourable member was asked for by the Sanitary Reform League recently established at Manchester.

Mr. Walpole spoke highly of Mr. Taylor's Report, which is a most admirable essay on the sanitary defects of Liverpool, and an account of many abuses existing not alone there, but also in most of our large towns, and promised to give the Report and correspondence his best consideration. Probably before these remarks go to press, some portion, if not the whole, of the Report will be issued, and we commend it to the notice of all sincere sanitary reformers.

The Liverpool Town Council is applying to Parliament for nearly a million sterling for town improvements, but so little of this money is to be expended for *bonâ fide* sanitary purposes, that it is to be hoped Parliament will consider well before the Bill is allowed to pass; and there is no doubt that, for the future, *all* such bills will be watched much more narrowly than has hitherto been the case.

In most cases where large sums are asked for by our boroughs for so-called "improvements," it may be taken for granted that a considerable proportion of the money required finds its way into the pockets of persons more or less intimately connected with the corporation, who have land or buildings which they wish to be rid of at a remunerative price. We expect shortly to hear more of these "jobs."

A description of the state of Manchester will be found in a separate article in this Number, as also some account of Mr. Torrens's Artizans' and Labourers' Dwellings Bill.

Quarterly List of Publications received for Review.

1. The World before the Deluge. By Louis Figuier. A new edition, the Geological portion carefully revised and much original matter added by Henry W. Bristow, F.R.S., containing 24 Full-page Illustrations of Extinct Animals and Ideal Landscapes of the Ancient World, designed by Riou; and 202 Figures of Animals, Plants, and other Fossil Remains and Restorations. *Chapman & Hall.*

2. The Vegetable World; being a History of Plants, with their Botanical Descriptions and Peculiar Properties. By Louis Figuier. Illustrated with 446 Engravings interspersed through the text, and 24 Full-page Illustrations, chiefly drawn from Nature, by M. Faguet, Illustrator to the Botanical Course of the Faculty of Sciences of Paris. *Chapman & Hall.*

3. Principles of Geology; or, The Modern Changes of the Earth and its Inhabitants considered as Illustrative of Geology. By Sir Charles Lyell, Bart., M.A., F.R.S. Tenth edition. Vol. I., with Maps, Plates, and Woodcuts. 680 pp. 8vo. *John Murray.*

4. Useful Information for Engineers. Third Series. By Wm. Fairbairn, C.E., LL.D., F.R.S., &c. *Longmans & Co.*

5. Familiar Lectures on Scientific Subjects. By Sir John W. F. Herschel, Bart., K.H. 510 pp. Fcap. 8vo. *Alexander Strahan.*

6. Descriptive Astronomy. By George F. Chambers, F.R.A.S. 224 Illustrations. 850 pp. 8vo. *Macmillan & Co.*

7. Lectures on Public Health, delivered at the Royal College of Surgeons. By E. D. Mapother, M.D., Professor of Hygiene, Medical Officer of Health, City of Dublin. Second edition. Engravings. 660 pp. Fcap. 8vo. *Dublin: Fannin & Co.*

8. Modern Arithmetic: A Treatise adapted for School Work and Private Study. By Rev. John Hunter, M.A., formerly Vice-Principal of the National Society's Training College, Battersea. 450 pp. 12mo. *Longmans, Green, & Co.*

9. Fecundity, Fertility, Sterility, and Allied Topics. By J. Matthews Duncan, A.M., M.D., Lecturer on Midwifery in Surgeons' Hall Medical School, Edinburgh. 380 pp. 8vo. *A. & C. Black.*

10. The Twin Records of Creation; or, Geology and Genesis: their Harmony and wonderful Concord. By Geo. W. Victor Le Vaux. With numerous Illustrations. 250 pp. Fcap. 8vo. *Lockwood & Co.*

11. A Journey to Ashango-Land: and further penetration into Equatorial Africa. By Paul B. du Chaillu. With Plates and Map. 500 pp. 8vo. *John Murray.*

12. Theoretical Astronomy, Examined and Exposed. By "Common Sense." 140 pp. 8vo. *Job Caudwell.*

13. L'Année Scientifique et Industrielle. Par Louis Figuier. *Paris: Hachette & Co.*

14. Les Merveilles de la Science, ou Description Populaire des Inventions Modernes. (*Numerous illustrations.*) *Paris: Furne, Jouvet & Cie.*

15. The Elements. An Investigation of the Forces which determine the Position and Movements of the Ocean and Atmosphere. By W. L, Jordan. Vol. XI. *Longmans & Co.*

16. Chemistry, Inorganic and Organic. With Experiments and a Comparison of Equivalent and Molecular Formulæ. By Charles Loudon Bloxam, Professor of Practical Chemistry in King's College, London. With 276 Wood Engravings. 700 pp. 8vo. *J. Churchill & Sons.*

17. Intercolonial Exhibition, 1866. Mining and Mineral Statistics. By R. Brough Smyth, F.G.S., Secretary of Mines for the Colony of Victoria. 40 pp. 8vo.

PAMPHLETS, PERIODICALS, PROCEEDINGS OF SOCIETIES, &c.

Classification of the Functions of the Human Body, and the Principles on which it rests. By Andrew Buchanan, M.D., Professor of Physiology in the University of Glasgow. 24 pp., 8vo. *J. Churchill & Sons.*

Sketch of the Mineralogy of Nova Scotia, as illustrated by the Collections of Minerals sent to the Paris Exhibition, 1867. By Professor How, D.C.L., University of King's College, Windsor, N.S. 6 pp. 8vo.

The Water Question; a Letter addressed (by permission) to the Right Hon. The Earl of Derby, K.G., &c., explaining a Proposal for the Supply of the Metropolis from the higher Source of the Thames in conjunction with the Storage of Surplus Waters. By J. Bailey Denton, C.E. *London: Stanford.*

Phases in the Developmental History of Infusorial Animal Life. By Jabez Hogg, M.R.C.S.

Tenth Annual Report of the Works executed by the Board of Works for the Whitechapel District. *From the Board.*

On Ozone. By Charles Daubeny, M.D., F.R.S. *From the Author.*

The Martindale Luminary. Broad Sheet. *From America.*

The Development of Science among Nations. By Baron Justus Liebig, F.R.S. 32 pp. Demy 8vo. *Edmonston & Douglas.*

On the Recent Suspension by the Board of Trade of Cautionary Storm Warnings. By Joseph Baxendell, F.R.A.S. 4½ pp. 8vo.

Matter: Its Ministry to Life in Health and Disease, and Earth as the Natural Link between Organic and Inorganic Matter. By Thomas Hawksley, M.D. Lond. *Churchill & Sons.*

Comparisons of the Icebergs of Belle-Isle, with the Glaciers of Mont Blanc, with Reference to the Boulder-Clay of Canada. By J. W. Dawson, LL.D., F.R.S., F.G.S., Principal of McGill College.

On the Conditions of the Deposition of Coal, more especially as Illustrated by the Coal Formation of Nova Scotia and New Brunswick. By J. W. Dawson, LL.D., F.R.S., &c.

The Evidence of Fossil Plants as to the Climate of the Post-pliocene Period in Canada. By J. W. Dawson, LL.D., F.R.S., &c.

Annual Report of the Miners' Association of Cornwall and Devonshire. By R. Hunt, F.R.S., Hon. Sec. *Truro: Heard & Sons.*

Notes for a History of Sanitary Legislation. By Edwin Lankester, M.D., F.R.S. *Chapman & Hall.*

The Fourth Annual Report of the Coroner for the Central District of Middlesex. From Aug. 1, 1865, to July 31, 1866. By Edwin Lankester, M.D., F.R.S.

The Artizans' and Labourers' Dwellings Bill.

The Annual Report of the Improved Labourers' Dwellings Society.

The Glacial Period in North America. By Thomas Belt, F.G.S.

Revue Universelle des Mines, de la Métallurgie, &c. Bureaux; Paris, Rue St-Dominique-St-Germain, nº 11; Liége, Place St-Paul, nº 6.

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation. *Paris: Masson.*

Journal de Médecine Mentale. *Paris: Masson.*

Le Mouvement Médical, Journal de Santé Publique. M. V. Groupy, 5, Rue Garancière.

The Westminster Review.

The Geological Magazine.

Proceedings of the Royal Society.
" " Royal Astronomical Society.
" " Royal Geographical Society.
" " Chemical Society.
" " Geological Society.
" " Zoological Society.

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The Editors will be glad to receive the Printed Proceedings of Local Boards of Health, and of other Sanitary Corporations, to which due consideration will be given by the Editor of the Quarterly Article on the Public Health.

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THE QUARTERLY

JOURNAL OF SCIENCE.

JULY, 1867.

I. THE WATER SUPPLY OF LONDON, AND THE CHOLERA.

By E. FRANKLAND, F.R.S., Professor of Chemistry in the Royal Institution of Great Britain and in the Royal School of Mines.

THE growth of nearly every large town has involved a succession of struggles for the supply of its inhabitants with pure water. Even the aggregation of a few houses forming a village not unfrequently causes a sensible pollution of the water supply, if the wells be sufficiently shallow. As the village develops into a town, the water from such sources not only becomes dangerous from impurity, but also totally insufficient in quantity for the increasing population. Recourse is then had to a neighbouring stream for a purer and more copious supply; but greater abundance of the useful liquid determines the production of a larger volume of sewage, part of which, as the town extends itself along the banks of the stream, begins to be discharged above the point at which the water supply is withdrawn. Contamination again ensues, and the place of withdrawal is removed higher up the river. Relief is thus obtained, but it is only temporary; villages nearer the source of the stream grow into small towns, and the struggle is only terminated by seizing upon and impounding the very sources of the stream itself, by which alone a permanently wholesome and untainted beverage can be secured. Such is the history of water supply in most large towns, and such is, or must be, its history in the English capital. Another visitation of the most terrible epidemic to which modern London is still subject has once more called earnest attention to the serious defects of the metropolitan water supply. It will require much acute observation and laborious experimental research before the origin and spread of cholera will be thoroughly understood; but there are certain prominent features in the character of this epidemic which at once arrest attention and at least suggest the direction in which further inquiry would probably lead to discovery. In the first place we find cholera making its appearance in various localities, healthy or otherwise, and frequently without any apparent cause. Such sporadic attacks occur equally in large towns and in isolated hamlets; as a rule, they carry off the first victim and one or two of his friends or neighbours, whose contact, either direct or indirect, with his dejections can frequently be traced. The disease, however, does not spread farther, but soon becomes extinct, to break out again perhaps in a similar manner after the lapse of weeks or months. In this way, isolated attacks were continually occurring during the summer and autumn of 1866 in Manchester and Birmingham, as well as in scores of small villages and isolated hamlets scattered throughout the whole United Kingdom. Such irregular and sporadic assaults powerfully suggest the presence of a specific poison in the atmosphere suspended as impalpable spores or germs, not therefore obeying the law of the diffusion of gases, but depending upon currents of air for their transport from place to place; in fact, behaving exactly like the spores of green mould or those of the fungus known to gardeners as *damp*, both of which have so completely taken possession of our atmosphere, that there is probably not a cubic foot of air near the earth's surface which does not contain numbers of them. But these germs, though present everywhere, cannot grow and reproduce themselves except under certain favourable conditions. Place a piece of calf's-foot jelly in a dry atmosphere and it will not become mouldy, but a few hours' sojourn in a damp closet will infallibly cover it with a perfect forest of vegetation. Again, let a geranium be placed in the open air or in a well-ventilated and well-lighted conservatory, and its leaves and stems will continue green and healthy, but let either the light or ventilation be bad, and the plant "damps," that is, it becomes covered with a fungus which rapidly destroys its vitality. Thus both kinds of vegetable spores are incapable of vivification without certain favourable conditions, which are moreover peculiar for each description of organism.

The cholera poison, if present in the atmosphere, doubtless also requires a favourable conjunction of conditions to render its development possible. If one of these conditions be absent, the concurrence of all the others is insufficient to produce the effect. Thus, it is highly probable that in the case of cholera, as in that of other epidemic diseases, there are many individuals who, during the time of the epidemic at least, are in such a condition of body as to be absolutely incapable of taking the disease, even if every other favourable circumstance be present. But besides the bodily capacity for the effective reception of the cholera germ, there appears to be in most, probably in all, cases, one other condition at least necessary. This condition may be supplied in food and drink. A young girl in the little village of Farrington, in Lancashire, eats a quarter of a peck of green apples; within twelve hours she is seized with cholera and dies. Another girl does precisely the same thing in Pimlico, and a like result follows. Such are the causes of the so-called sporadic cases of cholera. It is scarcely conceivable that the cholera poison was present in the apples more than in any other article of daily food, but the fruit supplied the only condition wanting to enable the poison to vivify and propagate itself in the system. Now if, during the prevalence of cholera, all the inhabitants of a town, or of one particular quarter of a town, were to eat daily this excessive amount of apples, can it be doubted that the disease would assume what is called its epidemic form, and would attack such of the fruit eaters as were unfortunate enough to be capable of vivifying and propagating the poison?

Communities do not, however, thus consume inordinate quantities of apples, or other fruit capable of affording a congenial soil for the cholera germ; but it is evident that if the necessary material were present in bread, milk, butter, or tea, the disease would at once assume its epidemic form throughout the country. Now of all materials which have been observed to determine an attack of cholera there is one which stands pre-eminent. Evidence of the most conclusive character from numerous independent and trustworthy sources points to one material as that best adapted, when introduced into the human stomach, to vivify and develop the cholera germ. This material is sewage. Whether sewage forms a congenial soil for the cholera spores supplied to it from the air or from cholera patients, and thus introduces those spores in an already vivified condition into the stomach, or whether it merely supplies the material for their growth and propagation in the intestines may be disputed, but, divested of all theory whatever, the fact still remains clear and incontrovertible that amongst the materials which, during the prevalence of the disease, produce cholera when taken internally, sewage is the most effective; and this property sewage preserves, although in a diminished degree, even when largely diluted. In the supply of a family with water contaminated with sewage, the necessary condition for the production of *sporadic cholera* is provided, and in the supply of such a water to a community we furnish the necessary condition for the establishment of *epidemic cholera.*

The history of cholera epidemics furnishes abundant evidence in support of both these propositions; I must content myself, however, by quoting the following cases. On the 18th day of August last a family from London went to reside at Upper Marine Terrace, Margate. On the evening of August 26th a heavy thunderstorm visited the town, and an unusually large quantity of rain fell. The hot water that was brought to the bedrooms the next morning emitted a peculiar smell, and a glass of cold water was turbid and had an unpleasant taste. The water was supplied from a well at the bottom of the garden. During the ensuing night four of the inmates of the house were simultaneously attacked by choleraic diarrhœa, and during the following day several others. Two of those attacked during the night died on the evening of that day; their deaths are registered as caused by choleraic diarrhœa. The waiting boy, who was quite well at noon on that day, died of Asiatic cholera before midnight, and a lady died on the 1st of September following of the same disease. Three other inmates of the same house returned to St. John's Wood, London, immediately; but they were all attacked by Asiatic cholera: one of them died on the 1st of September, another two days later, whilst the third recovered.

A sample of the well-water used by the inmates of this house was taken on the 30th of August and sent to me for analysis. It contained 93·4 parts of solid matter in 100,000 parts; of this the very large amount of 7·36 parts consisted of organic and other volatile matter. There is a cesspool situated near to this well, and it can scarcely be doubted that, during the thunderstorm above mentioned, this cesspool overflowed into the well, causing the fatal contamination; for on analytically examining a sample of water collected from the same well on the 18th of September following, I found its character entirely changed. It now contained 82·75 parts of solid impurity in 100,000 parts of water, and of these only 1·13 part was organic or other volatile matter. It was clearly ascertained that the water of this well was drunk by all those attacked.*

Such is the history of the sporadic outbreak of the disease, costing six lives. Dr. Lankester, in his article on the public health in the January number of this Journal, mentions a parallel case which occurred in Epping Forest and resulted in the death of eight persons. Here again it was clearly proved that the overflow from a cesspool passed directly into the well from which the household derived their supply of water. The celebrated case of the Broad-street pump, which in 1854 caused the terrible outbreak of cholera in the parish of St. James, Westminster, forms as it were a connecting link between the above sporadic explosions and the gigantic epidemics which devastated London in 1849, 1854, and 1866. Dr. Farr has conclusively shown, not only that these epidemics were directly connected with the supply of water contaminated with sewage, but also that the violence of the epidemic depended upon the degree of contamination of the water supply. Thus it was shown that, in the visitation of 1849, that portion of the metropolitan population which was supplied by water taken from the Thames, at Kew, suffered a mortality from cholera of 8 in 10,000. Of every 10,000 people supplied with water taken from the river at Hammersmith, 17 died. Of the inhabitants of Belgravia, St. George's, Hanover-square, Chelsea, and Westminster, supplied with water taken below Chelsea Hospital, 47 in 10,000 died. Whilst the populations drawing their supply still lower down, *viz.* at Battersea, and between Hungerford and Waterloo bridges, where the river was still more foul, suffered to the extent of 163 in 10,000. In the year 1854 one-half of this latter district was supplied by water taken above Teddington Lock, and the deaths fell to 87—little more than one-half; whilst last year, when the whole supply was drawn above Teddington Lock, the loss of life from cholera was only 8 in 10,000. Again Manchester, which is in other respects one of the most unhealthy cities in the United Kingdom, furnishes remarkable evidence that cholera can never establish itself as an epidemic unless the water supply of a community be tainted with organic impurity; this city suffered fearfully from cholera in 1832 and 1849 whilst supplied with impure water, but after the introduction of pure water from the Derbyshire hills, the return of the disease in 1854, and again last year, manifested itself in Manchester by a few sporadic cases only.

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* For further particulars of this case, see the supplement of the weekly return of the Registrar-General for the week ending 24th November, 1866.

All the water withdrawn from the Thames for the supply of London is now taken above Teddington Lock, and its filtration before distribution is rendered compulsory by the Metropolitan Water Act of 1852. The wisdom of thus taking the water at a higher point and of enforcing its filtration is evidenced by the comparative slight mortality from cholera last year in those districts supplied with Thames water. Far different, according to the returns of the Registrar-General, was the fate of that portion of the metropolis which had the misfortune to be supplied from reservoirs at Old Ford, belonging to the East London Water Company. The suddenness and virulence of the outbreak of cholera in the east of London last summer at once aroused the suspicions of the Registrar-General, who requested me to make an immediate investigation into the East London Water Company's supply. I found the chief reservoir at Old Ford to be situated close to the river Lea, which is there little better than an open sewer. This reservoir is also sunk 16 feet beneath the low ground, which is there only just above the level of spring tides; consequently the water in the reservoir is always below Trinity high-water mark. It was evident that soakage from the adjacent foul river and from the surrounding soil, saturated as it was with sewage, must take place into such an excavation with its floor of two and a half acres in extent, and this has since been confirmed by recent investigation when this reservoir was emptied as far as possible by pumping. The foreman at the

Old Ford Water Works has also since admitted that he distributed *unfiltered* water from one of these reservoirs a few days previous to the cholera outbreak. The mortality in that portion of London supplied from the Old Ford reservoirs was frightful, for whilst the deaths in the districts drawing water from other sources varied from 2 to 12 in 10,000, they ranged from 63 to 111 in 10,000 in those districts supplied from these reservoirs.

London is at present supplied with water by nine companies, who deliver about 108,000,000 gallons daily. A better idea may be formed of the vastness of this supply by a comparison of its volume with some well-known magnitude. If it were contained in a reservoir having a floor-area equal to that of Westminster Hall, the walls would require to be carried to the height of 1,070 feet, or more than three times the height of the Victoria tower, to enable it to contain the water which is daily distributed in the metropolis. Five of the water companies abstract about one-half of the total supply from the Thames; two withdraw about 42,000,000 gallons from the river Lea, and the remainder is pumped by two other companies (the Kent and South Essex Companies) from Artesian wells sunk into the chalk of the Thames basin. Such is the present volume of water daily supplied to London and its suburbs; what will be the amount required twenty years hence, it is difficult to estimate, but if the annual rate of increase since 1850 be continued, it can scarcely be less than 150,000,000 of gallons; for in 1850 the gross daily quantity delivered was only 44½ millions of gallons, in 1856 it had reached 81,000,000 gallons, whilst in 1865 it was 108,000,000 gallons.

Notwithstanding the best efforts of the water companies, the present supply of water to the metropolis is far from satisfactory, owing to causes which are mostly beyond the control of those to whom that supply is entrusted; it is therefore contemplated either to change entirely the source, and thus obtain water of greater purity than any available in the neighbourhood of London, or so to alter the conditions at present affecting Thames water as to materially improve its quality. For this purpose no less than five schemes have been recently brought forward, *viz.*:—

1. Sources of the Severn, proposed by Mr. Bateman.
2. The Cumberland Lakes—Messrs. Hemans and Hassard.
3. Thames water filtered through Bagshot Sands—Mr. Telford Macneill.
4. Storage reservoirs near the sources of the Thames—Mr. Bailey Denton.
5. Derbyshire and Staffordshire hills—Mr. Remington.

The first two of these schemes have been recently so ably discussed in this Journal by Mr. Edward Hull, that it will be only necessary here to allude to the chemical quality of the water; the remaining three schemes have not yet been sufficiently matured to permit of their treatment from a chemical point of view. The first two colossal schemes are truly worthy of this age of engineering triumphs, and of the great city on behalf of which they are projected. Before the advantages of such magnificent undertakings can be appreciated, however, it is necessary first to consider the chemical quality of our present supply, and then to compare it with that of the water which the new sources are capable of furnishing.

The impurities present, or liable to be present, in the waters supplied to the metropolis may be thus classified:—

Innocuous.	Soap destroying.	Previous sewage contamination.	Present sewage contamination.
Common salt.	Salts of lime and magnesia.	Nitrates, nitrites, and ammonia.	Nitrogenous organic matter.

The most important things to be ascertained respecting the impurities in water used for domestic purposes are—first, the amount of sewage contamination previous and present; and secondly, the quantity of soap-destroying materials. The organic matters, containing nitrogen which occur dissolved in water, are chiefly, if not entirely, of animal origin, being derived either from sewage or manured land; be their origin, however, animal or vegetable, no distinction founded upon their source can be drawn between their respective noxious qualities. After admixture with spring or river water, these noxious organic matters undergo slow oxidation, by which they are finally resolved into comparatively innocuous mineral compounds; their carbon is converted into carbonic acid gas, and their hydrogen into water, and these products can no longer be identified in the aërated waters of the river or spring; but the nitrogen is converted into nitrous and nitric acids, which, combining with the bases contained in most waters, remain dissolved, and constitute a record of the sewage or other analogous contamination to which the water has been subject. With certain corrections presently to be mentioned, the analytical determination of the nitrogen contained in these salts and in the form of ammonia writes, as it were, the history of the water, as regards its contact with decomposing animal matter. Such previous organic contamination may be conveniently expressed in parts of average filtered London sewage, which, if thus completely oxidized in a river, would yield a like amount of nitrogen, in the form of nitrites, nitrates, and ammonia. For this purpose, average filtered London sewage may be taken as containing ten parts of combined nitrogen in 100,000 parts, as deduced from the numerous analyses of Way, Hofmann, and Witt. The number so obtained as the *previous sewage contamination* of a water requires, however, a correction, since rain-water itself contains combined nitrogen in the forms of ammonia, nitrite of ammonia, and nitrate of ammonia. The amount of these substances present in rain which falls at Rothampstead has been most carefully determined by a laborious series of monthly analyses, made independently on the one hand by Messrs. Lawes and Gilbert, and on the other by Professor Way, and extending over two years. The results of these chemists accord well, and they give as the average amount of nitrogen in the forms of ammonia, nitrite of ammonia, and nitrate of ammonia, ·0985 parts in 100,000 parts of rain-water. This must be deducted therefore from the calculated amount of previous sewage contamination of any sample of water. It corresponds to 985 parts of previous sewage contamination in 100,000 parts of the water. There is no doubt that this reduction is too large, and therefore favourable to the character of the water, since in most cases but a very small proportion of the water of a river or spring falls as rain directly into the stream; and Professor Way has proved that almost every trace of the ammonia contained in rain-water is absorbed when the water percolates through cultivated soils. Now, as three-fourths of the combined nitrogen in rain-water is in the form of ammonia, it is evident that rain-water must be deprived of much of its original nitrogenous contamination before it reaches such a river as the Thames. The very small amount of combined nitrogen found in natural waters of undoubted purity, such as that of Loch Katrine for instance, also testifies to the liberality of the above allowance. The water of Loch Katrine contains only one-third as much combined nitrogen as that present in the rain falling at Rothampstead, so that, starting from the base line of purity above proposed, the water of Loch Katrine exhibits a *negative* previous sewage contamination equal to 575 parts in 100,000; or, in other words, it would require 575 parts of average London sewage to be added to, and allowed to oxidize in each 100,000 parts of Loch Katrine water before the purity of the latter would be reduced to the standard with which I propose to compare the metropolitan waters. It is necessary here to remark, however, that owing to the more copious rains of the Highlands of Scotland, the rain-water of that district probably contains less combined nitrogen than that which falls at Rothampstead. The following table exhibits the amount of total solid impurity contained in 100,000 parts of the metropolitan waters in the months of February and April last; it also shows the amount of carbon contained in the organic matter forming part of that solid impurity; the amount of nitrogen in the salts of nitrous and nitric acids; the quantity of ammonia, and finally the amount of previous sewage contamination. For the purpose of comparison the results yielded by Loch Katrine water as supplied to Glasgow in February last are appended.

Quality of the Waters supplied to the Metropolis during the Months of February and April, 1867.

1. Names of Companies.	2. Total solid Impurity in 100,000 parts of Water.		3. Organic Carbon.		4. Nitrogen as Nitrates and Nitrites		5. Ammonia.		6. Previous Sewage Contamination.	
	Feb.	April.	Feb.	April.	Feb.	April.	Feb.	April.	Feb.	April.
THAMES.										
Chelsea	28·58	27·86	·433	·267	·337	·267	·004	·002	2420	2195
West Middlesex . . .	28·68	28·06	·340	·224	·356	·269	·006	·004	2630	2245
Southwark and Vauxhall	29·08	28·52	·293	·166	·357	·298	·005	·002	2630	1945
Grand Junction . . .	29·44	28·20	·417	·218	·322	·248	·004	·004	2270	2115
Lambeth	29·36	28·68	·423	·164	·341	·290	·005	·004	2470	2635
OTHER SOURCES.										
New River	29·72	26·44	·272	·273	·350	·274	·003	·002	2540	3155
East London	33·56	27·82	·293	·382	·357	·264	·004	·010	2620	2295
Kent	39·84	40·12	·088	·131	·421	·409	·008	·002	3300	2155
South Essex	38·32	—	·143	—	·844	—	·007	—	7520	—
Water from Loch Katrine as supplied in Glasgow	3·28	—	·256	—	·031	—	·002	—	0	—

This table is to be read in the following manner:—100,000 lbs. of the Chelsea Company's water contained in the month of February last 28·58 lbs. of solid impurity: the organic matter constituting a portion of this impurity contained 0·433 lb. of carbon. This solid impurity also contained 0·337 lb. of nitrogen in the form of nitrates and nitrites, besides 0·004 lb. of ammonia. The above quantity of water as supplied by the Chelsea Company had been, after its descent to the earth as rain, contaminated with sewage or the manure of cultivated land equivalent to 2,420 lbs. of average London sewage. By gradual oxidation, partly in the pores in the soil, partly in the Thames and its tributaries, and partly in the reservoirs, filters, and conduits of the Chelsea Water Company, this sewage contamination had been entirely converted into comparatively innocuous inorganic compounds before its delivery to consumers.

A glance at the table shows how vastly superior is the quality of the water of Loch Katrine as compared with that of the best at present supplied to London. 100,000 lbs. of this water contain but 3·28 lbs. of solid impurity, of which only 0·031 lb. is nitrogen in the form of nitrates and nitrites, and 0·002 lb. of ammonia. Further, Loch Katrine water exhibits no sewage contamination, either previous or present.

The nitrogenous organic matter which has escaped the process of oxidation above described, and which therefore still exists in the water at the time the analysis is made, constitutes what may be appropriately termed the *present sewage contamination* of the water.

The amount of this contamination may be expressed by the number of parts of average filtered London sewage (of the strength above described), which, if contained in 100,000 parts of pure water, would contaminate the latter with the same amount of combined nitrogen. No contamination of this nature has yet been detected in the waters supplied to the metropolis, but the investigations for its discovery have only been made since February last. It will doubtless be consolatory to the consumers of Thames water to know that, although, according to Mr. Bateman, the population within the basin of the Thames above the points at which the water is withdrawn for the supply of London exceeds 1,000,000 persons, the drainage of some 600,000 of whom is poured into the river, the whole of this fæcal matter is so completely oxidized before it reaches the water-cisterns of London as to defy the detection of any trace in its noxious or unoxidized condition. If the average flow of Thames water just above the point at which the London Companies withdraw their supply be taken at 800,000,000 of gallons daily, the drainage of 600,000 people ought to produce a sewage contamination of 2,250 parts in 100,000. It could scarcely be expected that this calculated number should approximate very closely to that obtained by the actual analysis of Thames water, since the calculated number depends upon many contingencies, as for instance, upon the volume of water actually flowing past the points of withdrawal at the time the companies abstracted the water analyzed; and secondly, upon the greater or less retention of the fæcal matters, in the sewers of the towns draining into the river. It is interesting, however, to find that the sewage contamination of Thames water, as determined by analysis, does not differ much from that calculated according to the above data. The analytical table given above shows that the average previous sewage contamination of the water delivered by the five companies drawing their supply from the Thames during the months of February and April, 1867, was 2,355 parts in 100,000 of water, the amount calculated from the number of persons draining into the river being, as just mentioned, 2,250 parts in 100,000 of water. As summer advances and aquatic vegetation becomes vigorous in the bed of the Thames and its tributaries, this coincidence of calculated and analytical results will probably be disturbed, as the water-plants can scarcely fail to withdraw an appreciable amount of nitrates and nitrites from the water, thus diminishing the quantity of combined nitrogen and consequently of previous sewage contamination as determined by analysis.

The second important class of impurities contained in water used for domestic purposes consists of certain mineral salts which possess the power of decomposing soap. These substances are the hardening or soap-destroying constituents of water. From a purely sanitary point of view they are of less direct importance than the organic impurities; still, by rendering efficient ablution and thorough cleanliness difficult of obtainment, they doubtless indirectly affect the health of communities supplied with waters in which they are present in considerable quantities.

The chief hardening ingredients in potable waters are the salts of lime and magnesia. These salts decompose soap; forming curdy and insoluble compounds containing the fatty acids of the soap and the lime and magnesia of the salts. So long as this decomposition goes on the soap fails to produce a frothiness in the water, but when all the lime and magnesia salts have been decomposed by the action of the soap, the slightest further addition of the latter produces a lather when the water is agitated; but this lather is again destroyed by the addition of a further quantity of the hard water. Thus, the addition of hard water to a solution of soap—or the reverse of this operation—causes the production of the insoluble curdy matter above mentioned. Bearing this in mind, it is easy to understand the process of washing the skin with soap and hard water, which may be thus described:—First, the skin is wetted with the water, then soap is applied; the latter soon decomposes all the hardening salts contained in the small quantity of water with which the skin is covered, and there is then formed a strong solution of soap, which penetrates into the pores of the skin. This is the process which goes on whilst a lather is being produced in washing, but now the lather requires to be removed from the skin; how can this be done? Obviously only in one of two ways, *viz.* by wiping it off with a towel or by rinsing it away with water. In the former case, the pores of the skin are left filled with soap solution; in the latter, they become plugged up with the greasy curdy matter which results from the action of the hard water upon the soap solution occupying the pores of the cuticle. As the latter process of removing the lather is the one universally adopted, the operation of washing with soap and hard water is perfectly analogous to that used by the dyer or calico printer when he wishes to fix a pigment in the pores of any tissue. He first introduces into the tubes of the fibre of calico, for instance, a liquid containing one of the ingredients necessary for the formation of the insoluble pigment, this is followed by another liquid containing the remaining necessary ingredients, the insoluble pigment is then produced within the very tubes of the cotton fibre, and is thus imprisoned in such a manner as to defy removal by subsequent washing. The process of ablution, therefore, in hard water is essentially one of dyeing the skin with the white insoluble greasy and curdy salts of the fatty acids contained in soap. The pores of the skin are thus blocked up, and it is only because the insoluble pigment produced is white that such a repulsive operation is tolerated. To those, however, who have been accustomed to wash in soft water, the abnormal condition of the skin thus induced is for a long time extremely unpleasant.

Nevertheless, opinion is not quite unanimous as to the advantages of soft water over hard. Some persons consider hard water to be necessary for the supply of the calcareous matter of the bones, others believe soft water to be peculiarly liable to attack and dissolve the lead of the pipes through which it is conveyed, or of the cisterns in which it is stored.

An examination of the grounds upon which these opinions are based would completely refute them, but the limits of this article do not permit of such a digression, and I must therefore content myself with a mere allusion to one or two facts in connection with them. First, as to the necessity of hard water for the supply of the calcareous matter of bones. If it be assumed that a man drinks daily half a gallon of Thames water, he obtains from it 3¾ grains of lime chiefly in the form of chalk. This amounts to not quite 3 oz. per annum, which does not seem to be a very large contribution to bony matter. Now suppose the use of this water to be discontinued and that no part of it is replaced by bitter beer, which always contains far more lime in a given volume than Thames water; but we will assume that the individual consumes one-third of a pint of milk per day, he then receives in this quantity of milk more lime than his system can acquire from two quarts of Thames water. Then, as to soft water attacking and dissolving lead; it is by no means true, as a general proposition, that soft water does attack and dissolve this metal. The very soft water of Loch Ness, as supplied to Inverness, does not attack lead, as evidenced by the unimpaired condition of lead pipes through which that water flowed for six years: neither does the soft water of Ennerdale Lake, supplied to Whitehaven, attack lead. Even those soft waters which do attack the metal, such as those now supplied to Glasgow and Manchester, only do so when the surface of the lead is clean and bright. The action soon ceases, in fact as soon as the metal becomes tarnished the pipes are protected, and no complaints of any symptoms of lead poisoning have for the past ten years been heard from these large cities. Lastly, a sample of very soft water taken from one of the principal streams from which it is proposed to supply London has no action even upon clean and bright lead. Notwithstanding the numerous researches made in connection with this subject, the causes of the attack of lead by water have not yet been completely elucidated; it has, however, been established that the presence of oxygen and the comparative absence of carbonic acid in the dissolved gases are essential conditions to this action. Messrs. Graham, Miller, and Hofmann, in their report on the Metropolitan Waters in 1851, first showed that carbonic acid when dissolved in water was a complete protection against lead contamination, and from a series of experiments recently made I find that 2 volumes of carbonic acid dissolved in 100 volumes of water completely protect even distilled water from such contamination. Rain water as it descends to the earth dissolves atmospheric gases, and this solution is afterwards continued in brooks and rivers. Of the chief atmospheric gases, carbonic acid is by far the most soluble, 100 volumes of pure water can dissolve 100 volumes of this gas; oxygen, on the other hand, only dissolves to the extent of 3 volumes in 100 volumes of water. Nevertheless, owing to the much larger proportion of oxygen than of carbonic acid in atmospheric air (500 : 1), water takes up oxygen more rapidly than carbonic acid, and hence freshly fallen rain-water acts upon lead; but when the water flows a great distance through an open conduit, the carbonic acid absorbed finally reaches the protecting proportion, and the action upon lead ceases, although the water retains its original softness. Hence there is no necessary connection between soft water and lead corrosion. Even distilled water left in contact with the air for some time loses its property of acting upon lead.

The hardness of a water is expressed in parts of carbonate of lime, or of its equivalent of other hardening salts, contained in 100,000 parts of the water, and each part of carbonate of lime contained in this quantity of water is generally termed a degree of hardness. This quality of the water may also be more popularly though less accurately expressed by the number of parts of soap destroyed or wasted by 100,000 parts of the water when used for washing purposes. Each degree of hardness indicates the destruction of 12 parts of the best hard soap by 100,000 parts of water. The following table shows the hardness of the London and Loch Katrine waters, according to both these methods of expression:—

Names of Companies.	Hardness.		Soap Destroyed.	
	February.	April.	February.	April.
Thames.				
Chelsea	16·2	17·7	194·4	212·4
West Middlesex . .	16·2	16·3	194·4	195·6
Southwark & Vauxhall	16·8	17·7	201·6	212·4
Grand Junction . .	17·1	17·7	205·2	212·4
Lambeth	16·0	17·7	192·0	212·4
Other Sources.				
New River	18·5	16·3	222·0	195·6
East London . . .	18·8	16·0	225·6	192·0
Kent	23·1	21·1	277·2	253·2
South Essex . . .	21·1	—	253·2	—
Water from Loch Katrine as supplied in Glasgow	·3	—	3·6	—

According to this table, the Chelsea company's water possessed, in February last 16·2 degrees of hardness, and 100,000 lbs. of it, when used for washing, destroyed or wasted 194·4 lbs. of soap; whilst Loch Katrine water had only 0·3 degree of hardness, and 100,000 lbs. of this water destroyed only 3·6 lbs. of soap before the detergent action of the latter came into play. Such is the chemical history of the water at present supplied to the metropolis, and it must be borne in mind that, grave as are its defects, the mode of delivery of this water to consumers is still more defective. That in a densely populated city, water should be delivered only once, and for a few minutes, in twenty-four hours, and not at all on Sundays, is a condition of things utterly incompatible with the supply of wholesome and palatable water. Even if the water of Loch Katrine itself were delivered in London, according to the system at present adopted by the metropolitan water companies, it would infallibly be rendered unfit for human consumption after twenty-four hours' exposure to the vile atmosphere and sewer gases in which the water cisterns of London are systematically placed.

The fundamental defects of our present water supply may be thus summed up:—

1. Great previous sewage contamination.
2. Liability to present sewage contamination.
3. Great hardness.
4. Intermittent supply.

The waters from the sources of the Severn, and from the Cumberland lakes have not yet been submitted to the process of investigation above indicated, and it is therefore impossible to compare them in all respects with the present metropolitan supply. The water of the Bala Lake, in North Wales, which may be regarded as similar to that which would be supplied by Mr. Bateman's scheme, was examined by the late Dr. R. D. Thomson, and the waters of the Cumberland lakes have been more elaborately investigated by Professor Way. From the analyses of these chemists the following numbers are calculated:—

	Total solid impurity in 100,000 parts.	Hardness.	Soap destroyed.
Bala Lake . .	2·97	1°·1	13·2
Hawes Water .	5·70	2°·9	34·8
Ullswater . .	5·94	3°·0	36·0
Thirlmere . .	5·16	2 ·1	25·2

A comparison of these numbers with those given in the previous tables exhibits the great superiority of the proposed waters over those at present supplied to London, as regards total solid impurity and soap destroying ingredients; whilst it can scarcely be doubted that water obtained from such sources will be as free from deleterious organic contamination as that of Loch Katrine.

In the event of a new source of water supply being at once determined upon, at least seven years must elapse before it can be rendered available to the metropolis; it therefore becomes important to inquire how far it is possible in the interim to ameliorate our present supply. The first and most obvious improvement would be the substitution of the *constant* for the *intermittent* system of delivery. With certain restrictions, all the metropolitan companies express their willingness to make this change, and with the unanimity of opinion regarding its advisability, it is difficult to account for the delay in effecting it, unless it arise from the paltry cost involved in the alteration of present fittings, which would fall upon the landlords of small tenements. Most towns of importance in Great Britain have been long supplied with water on the constant system; why then is this boon denied to London, where it is much more urgently required? Until this alteration is effected it is, for the bulk of the population, almost useless to improve the quality of the water. Where a supply for one or even two days has to be stored in a filthy butt, exposed to the foul atmosphere of a crowded court or alley, good and wholesome water can never reach the lips of the consumers.

The most formidable danger arising from the use of the present water supply is undoubtedly the liability to actual sewage contamination such as that which there is every reason to believe destroyed so many lives in the East of London last summer. The fearful import of such contamination is most graphically described by Dr. Farr, in the report of the Registrar General for the week ending July 28th, 1866. It is greatly to be wished that these reports which contain the weekly results of the great hygienic reactions of the community were more generally studied by the public, and especially by those who watch over the public health. It would be difficult, if not impossible, to find in the same space matter of greater or more immediate importance to a civilized nation, and it scarcely admits of doubt that by the prompt action rendered possible by these reports, thousands of lives were saved last summer in the metropolis alone. Describing what he saw in one of his visits to the East of London during the height of the cholera epidemic, Dr. Farr says:—"The mortality is overwhelming in some of the districts. In Poplar alone, 145; in Bow, 188 people died last week, including Dr. Ansell, the meritorious health officer, and Mr. Seeley, clerk to the Board of Works, whose name figures on the placards. The people are falling ill every hour; you see them of all ages, children and adults, lying about their beds like people under the influence of a deadly poison; some acutely suffering, nearly all conscious of their fate and of all that is going on around them. Here the doctor is drawn in by the husband to see the wife now attacked; there the husband lies in spasms; here is an old woman seated dead with eyes wide open; there lies a fine four-year old child, his curly head drooping in death, but his mother says the pulse is strong and he takes what she gives him. An older brother just recovered is running about. Several wards of the London Hospital are full of patients, many of them very young children, in all stages of the disease; some dying, some well again and playing. The medical men have no rest, and with the Health Officers are nobly doing their duty; brave men ready to lay down their lives for their patients. The people themselves are most patient, most willing to help each other, the women always in front, and none shrinking danger. There is no desertion of children, husbands, wives, fathers, or mothers from fear."

This picture of misery, traced with such a high degree of probability by eminent medical authorities to the sewage pollution of water, suggests the inquiry whether or not anything can be done with regard to our present water supply to prevent such frightful accidents in future. How can we best protect ourselves against this noxious contamination? The answer is, there is no absolutely reliable protection. Filtration through animal charcoal is perhaps the best safeguard, but I have shown that this process fails to remove from water the matter which is believed to constitute cholera poison. Permanganate of potash is also an excellent purifier of water, but there is not the slightest evidence that this agent can destroy cholera poison. Boiling the water for a short time is no guarantee that its noxious qualities are destroyed, for even on the very probable supposition that cholera and other similar poisons are organic germs, we know that many such germs, especially those which are of a low type, retain their vitality after being boiled in water, or even after exposure to a temperature of 248° F. for a considerable time. The late Dr. Lindley mentions the fact of raspberry seeds germinating after being boiled for jam, and as syrup boils at a higher temperature than water these seeds must have been exposed to a heat considerably higher than that of boiling water. Nearly twenty years ago a curious red fungus or mould (*Oïdium aurantiacum*) attacked the bread of Paris. M. Payen exposed pieces of bread, upon which spores of the fungus had been sown, for half-an-hour to a temperature of 248° F. in tubes; the red fungus afterwards germinated, although its vitality was destroyed when the temperature was raised to 284° F. I have incontrovertible evidence of the production of violent cramps and diarrhœa by the drinking of tea made from water which, previous to boiling, had become contaminated with sewage.

Nevertheless, whilst none of these methods can be relied upon for the destruction of noxious organic matter in water, I am far from wishing to discourage their use as measures of precaution. More especially would I recommend filtration through animal charcoal as a most undoubted and valuable means of greatly reducing the amount of organic matter in water. I find that water will readily pass through a stratum of animal charcoal three feet thick at the rate of 41,472 gallons per day per square foot, the oxidizable organic matter contained in the water being reduced to one half. Five hundred tons of animal charcoal would be an ample quantity through which thus to pass the whole of the present metropolitan water supply. This at 13*l.* per ton would cost 6,500*l.* The charcoal would require to be heated to redness in retorts or ovens for a couple of hours every six months. It would last for two years and would then be worth nearly half its original cost as manure.

With regard to the excessive hardness of the London waters, it does not appear that any practicable scheme of amelioration has yet been contrived. Some years ago a beautiful and very simple process of softening hard waters by the addition of lime was devised by Dr. Clark of Aberdeen; but although this process has repeatedly been tried by water companies, it has invariably been again abandoned, since, notwithstanding the cheapness of the material employed, the amount of carbonate of lime deposited by the London waters, when submitted to this treatment, was, in the case of such vast volumes of water, so enormous as to cause the process to be pronounced impracticable. It is to be feared therefore that we must for the present be content to block up the pores of our skins with the greasy curd of hard water, but it is very desirable that the other ameliorations of which I have spoken should be carried out at once, although they ought not to delay the introduction of a water supply free from sewage contamination, for until such a supply reaches the metropolis its inhabitants will continue liable to repetitions of the terrible slaughter which occurred last summer, from the effects of which the east of London has not even yet recovered.

II. MR. JUKES AND THE GEOLOGICAL SOCIETY.*

It not unfrequently happens amongst large bodies of men whose affairs are conducted by a committee, council, or directorate, that the action of the executive will occasionally be disapproved of by some one or more individuals, who may even feel personally injured thereby. Such differences are not unknown amongst scientific societies, and we now propose to discuss one which has recently arisen between the council and a distinguished Fellow of one of the most prominent of the learned societies—the Geological Society of London.

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* 'Additional Notes on the Grouping of the Rocks of North Devon and West Somerset: with a Map and Section.' By J. Beete Jukes, M.A., F.R.S., &c. Preceded by an Introductory Statement. Printed for circulation among the Fellows of the Geological Society of London. Dublin: Webb & Son, 1867, pp. 37.

On March 7th of last year, Mr. J. B. Jukes, local director of the Geological Survey of Ireland, read before the Geological Society a paper "On the Carboniferous Slate (or Devonian rocks) and the Old Red Sandstone of South Ireland and North Devon," which was published in due course in the Society's 'Quarterly Journal,'* occupying fifty closely printed octavo pages. In this paper the author endeavoured to prove two points:—(1) that the Devonian rocks of North Devon are synchronous with the Carboniferous Slate of Ireland; and (2) that "the Lynton beds are on the same general horizon as those of Baggy Point and Marwood," although "there appears to be a regular ascending succession of rock-groups from Lynton to the latitude of Barnstaple," which Mr. Jukes endeavoured to explain by the aid of a "concealed fault running nearly east and west through the centre of North Devon with a large downthrow to the north.† In this way he split up the great mass of Devonian rocks of North Devon into alternate zones of Carboniferous Slate and Old Red Sandstone (considered as distinct from Devonian).

Than this hypothesis it would be difficult to conceive a more startling heresy in British geology, and the reading of the paper was consequently followed by an animated debate, in which every speaker dissented from the view now for the first time expounded in England. Nevertheless the paper was published in full, for the idea was apparently new, and it is possible that future discoveries may lend it confirmation. Its author saw, however, that to convince his associates further evidence was necessary, and accordingly on the 7th of last November he read a second paper, the title of which is prefaced to this article. This paper, it appears, the council of the Society declined to publish, except in the form of an abstract without illustrations; and as this decision did not fall in with the views of the author, the council, at his request, returned to him his manuscript and illustrations, and published only the title of his paper in the 'Quarterly Journal.' Mr. Jukes has therefore printed his second paper as a pamphlet, prefacing it with some observations on the action of the council (at which he felt very much aggrieved), and on the history of the subject, and has sent a copy to every Fellow of the Geological Society.

Having thus placed our readers in possession of the essential facts, we can now discuss that part of Mr. Jukes's preface relating to the action of the council, in which he strikes at the fundamental principle regulating the decisions of that body in regard to the publication of papers in the Society's journal.

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* *Op. cit.*, vol. xxii., No. 87, August, 1866, pp. 320–371.

† See also 'Quart. Journ. Science,' No. XII.

We must begin by observing that whatever may have been the practice of the council in former days, when it required some vigilance to ensure that the papers should treat strictly of questions of fact—such being the object for which the Society was originally founded—does not now concern us; and our author's smart observations on the subject are altogether irrelevant, although it is perfectly possible that Mr. Warburton and others may have been at times unreasonably autocratic.

It will be as well if we now quote from Mr. Jukes, for the information of our readers, what takes place after a paper has been read before the Society:—

"The paper is, at the next meeting of the council, referred to some Fellow of the Society, who is supposed to have special knowledge of the subjects treated of, and he is requested to answer a printed list of questions which are sent with it. These questions, as well as I can recollect them, inquire whether there is anything personally offensive in the paper; whether there is anything superfluous, or absurd, or manifestly contrary to the principles of the science in it; whether it should be published *in extenso* or only in abstract; whether it should be accompanied with the illustrations, or whether any or all of the latter can be dispensed with; and generally, in fact, what is to be done with the paper.

"If the referee have the requisite knowledge, and acts with judgment and impartiality, and takes sufficient trouble to master the paper, of course the system would act in practice as well as it was meant to do theoretically."

Mr. Jukes further illustrates his position as follows:—

"I have two or three times acted as referee, and the plan I adopted was to treat it very much as a matter of form, just to look over the paper to see if there was anything in it personally offensive or disrespectful to any one; any obvious *lapsus calami* which the author would wish to have his attention called to; or anything manifestly childish, such as attempts to reconcile geology with the Mosaic cosmogony; and, if not, to recommend that it be printed as a matter of course."

According to these extracts the Society undertakes to print in their journal every paper accepted for reading, if it does not contain, in the opinion of the referee and the council, anything personally offensive, or superfluous, or absurd, or manifestly contrary to the principles of the science. If this be true Mr. Jukes has a right to complain, for it would seem, from the intrinsic evidence presented by his paper, that its rejection must rest on other grounds than these.

There is, however, a common saying that one tale is always good until another is told, and Mr. Jukes's tale would certainly have been good to all but a select few, had not a prominent member of the council of the Society (who avowed himself to be one of the referees) read to the assembled Fellows at a recent meeting the first question on the printed list to which Mr. Jukes has referred, as follows:—

"Is it desirable that the paper, as it stands, should be published in the 'Quarterly Journal of the Society,' as containing *new facts*, or *new views* of the bearing of *admitted facts*, or apparently well-founded *corrections* of important *errors* as to *matters of fact?*"

It must be admitted that this gives the matter a different complexion, and by the light of this information it seems fairly a question whether the council were not justified in refusing to print more than an abstract of the paper. Unfortunately for Mr. Jukes, he cannot plead ignorance of the stipulations to be complied with, as he owns to having two or three times acted as referee, and must therefore have had the questions addressed to him over and over again. That he did not discharge his duty more conscientiously is to be regretted in every way; had he done so, he would probably not have taken umbrage at the fate of his own paper. The proper course for him to have followed as referee, if he did not approve of the rules of the Society in respect to the publishing of papers, is manifestly, as was observed by his commentator, to have declined to act. Then, remembering his experience as referee he would probably not have selected the Society's journal as a medium for the publication of his papers on North Devon, although he would thus have deprived hinself of the innocent excitement respecting his first paper, to which he acknowledges in the following paragraph:—

"As regards the paper just mentioned, I must confess that it was with some feeling of curiosity as to what would be done with it, that I sent it to the Geological Society of London, and after it was read I marked its progress through the council with some of the interest and amusement one feels in watching an uncertain experiment."

It may be asked, why did Mr. Jukes feel any uncertainty as to the publication of his first paper? Fortunately, since that matter was decided, the Royal Geological Society of Ireland have published a number of their journal, or Echo would still have been compelled to answer, Why? The opportune appearance of that publication a few months ago has, however, solved the mystery, and to this effect:—On May 10th, 1865, Mr. Jukes read a paper before that Society, entitled "Notes for a Comparison between the Rocks of the South-west of Ireland and those of North Devon and of Rhenish Prussia (in the neighbourhood of Coblentz)," and on December 8th, 1865, he read another, entitled "Further Notes on the Classification of the Rocks of North Devon;" and it appears to us that they contain the essence of his papers read before the Geological Society of London. The council of the latter body were probably ignorant of the contents of these Irish papers, or the probability is that they would have saved the cost of fifty pages of their journal. In other words, Mr. Jukes's first paper would have shared the fate of his second.

The council of the Geological Society are in the habit, according to Mr. Jukes, of referring papers to some Fellow, who is supposed to have special knowledge of the subject; and he gives an instance in respect of his first paper, in which the council took the opinion of two gentlemen before coming to a decision. If the council act with such care and deliberation it seems that the theoretical excellence of the referee system (admitted by Mr. Jukes) must be attained in practice. We have ourselves been unable to discover any important new facts in Mr. Jukes's second paper, or any "apparently well-founded corrections of errors as to matters of fact." There is certainly propounded a new view of an admitted fact; but as it is not supported by evidence it could have been given quite as well in an abstract. Moreover, it is so purely hypothetical, that had it been enunciated by a young geologist, it would have been considered too "manifestly childish" for argument. This view may be stated as follows:—Near Wiveliscombe an east and west fault was indicated long ago by Sir Henry De la Beche, stretching for a distance of not more than four miles, and probably less than three. Mr. Jukes's new view, unsupported by evidence, is that this fault is continued for nearly thirty miles in a westerly direction.

Contributors to the 'Quarterly Journal of the Geological Society' are very rarely given so ample a space as fifty pages for the enunciation and illustration of their views, and therefore Mr. Jukes seems a little unreasonable in complaining that considerable further space was not granted for the publication of so feeble an addition to his evidence as that before us. Fellows of the Society who were present at the reading of this paper will remember how prevalent was the opinion that its author, so far from strengthening his case on that evening, had considerably damaged it, by resorting to so far-fetched an expedient as that we have just noticed.

It is also incumbent upon the council of the Society to use the narrow limits of a yearly octavo volume to the best advantage, and there can be no doubt that the time, thought, and trouble expended on the subject by the council as a body, and individually by the respective referees, have contributed in a large measure to obtaining for the Society's journal the well-merited reputation which it enjoys both in England and on the Continent.

Finally, after a careful examination of the evidence, we are unable to come to any other conclusions than the following:—(1)

That Mr. Jukes, forgetting the Geological Society's rules, has felt aggrieved at the refusal to publish in full a paper whose fate he would doubtless have predicted, had he remembered the Society's regulations;* and (2), that he has precipitately written and printed an attack on the council of the Society without first ascertaining that his recollection of the Society's rules was sufficiently exact—a course which can only be compared to rushing into a law-suit without legal advice, on the strength of vague impressions, and with no real knowledge of facts.†

III. FOOD AS A MOTIVE POWER.

By C. W. Heaton, Professor of Chemistry to Charing-Cross Hospital Medical School.

No physiologist now doubts that the force exerted in and by an animal is derived from the combination of the oxygen absorbed in the lungs with the solid or liquid substances formed in the body from the food. Hence it follows that if the body remains unchanged in weight after a certain period of time, the force exerted in it during that period is accurately represented by the calorific value of the food, *minus* the calorific value of the excreta. If the body has increased in weight, a store of potential energy must have accumulated in it; whereas if it has diminished, some portion of the force developed must have been derived from the store provided by previous increase. To avoid unnecessary complexity, it is best to assume the first of these cases, that, namely, in which the food is exactly equal to the requirement of the body.

Whatever intermediate conditions it may assume, there can be no doubt that the force developed in the body is mainly expressed in the final forms of Heat and Mechanical Work. It becomes, therefore, a problem of the greatest importance both to physiology and to dietetics to determine the relation which these two great factors bear to each other and to the different constituents of human food. Much of the work effected by the muscles is afterwards converted, inside the body, into heat, while some of the heat, that, for instance, which is employed in evaporation, is reconverted into work; but these conversions, although they present the gravest difficulties in quantitative investigations, do not affect the main principles which we have to discuss.

The first problem obviously is to find from the day's food, the total amount of force, the actual energy, which it is capable of producing when burnt in the body. The materials for this calculation have been supplied by a series of most valuable experiments which have recently been conducted by Dr. Frankland, who published his results in a lecture delivered at the Royal Institution, June 8, 1866. He selected some of the most important articles of food, and burnt one gramme of each of them in a vessel surrounded with water. He noted carefully the extent to which the water became heated; from this it was easy to calculate the calorific value of the food, and from this its work-equivalent in metre-kilogrammes. In the case of nitrogenous foods, such as meat and bread, a certain portion always leaves the body without undergoing oxidation. The calorific value of this residue was determined by Frankland and deducted from that of the food, and we have therefore, for the first time, a trustworthy statement of the actual force-values of these substances. The following table contains a few of the most important figures. A great deal of the enormous differences perceived is due to the different quantities of water which the various substances contain; but even when they are compared in the dry state, great differences are observed. Fats and oils are superior to all other substances in this respect:—

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* Vol. i., Part 2, 1866.

† It speaks more for the impartiality of the council of the Geological Society that they refused a place to such an eminent geologist for his second paper, than that they granted it for his first against their convictions.—The Editors.

NAME OF FOOD.	Actual Energy of 1 gramme as burnt in body.	Weight and Cost of various articles required to be oxidized in the body to raise 140 lbs. to height of 10,000 feet.		
	Metre-kilogrammes.	Weight in lbs. required.	Price per lb.	Cost.
			s. d.	s. d.
Cod-liver oil	3857	0·553	3 6	1 11¼
Beef fat	3841	0·555	0 10	0 5½
Butter	3077	0·693	1 6	1 0½
Cheshire cheese	1846	1·156	0 10	0 11½
Oatmeal	1665	1·281	0 2¾	0 3½
Isinglass	1550	1·377	16 0	22 0½
Lump Sugar	1418	1·505	0 6	0 9
Bread	910	2·345	0 2	0 4¾
Lean beef	604	3·532	1 0	3 6½
Potatoes	422	5·068	0 1	0 5¼
Cabbage	178	12·020	0 1	1 0¼

It is curious to compare with these figures the calorific value of coal. The burning of 1 gramme of coal yields an actual energy of 2,538 metre-kilogrammes, and we will assume its price to be 25*s.* per ton. Equal quantities of force can then be obtained by the burning of—

Coal	costing	1*s.*		
Oatmeal	„	35*s.*		
Butter	„	125*s.*	or	£ 6 5*s.*
Lean beef	„	425*s.*	„	21 5*s.*

The food which is the cheapest enumerated as a force producer, is, thirty-five times as expensive as coal, and it is therefore not wonderful that human labour cannot compete in economy with that of the steam-engine. Food is, indeed, as Donders remarks, a very dear form of fuel.

We have now come to a question which is infinitely more complex than the first, and which embraces the most important of physiological problems. We may suppose ourselves acquainted with the composition and force-value of the food, and we have next to inquire what changes it undergoes and what are its functions in the organism. A complete discussion of this subject would be an elaborate treatise on physiology, and even so would unfortunately afford but a very imperfect answer to the questions. But a few points must be briefly glanced at, and they will serve as an introduction to some recently acquired theories and facts of great practical importance. In the first place it is essential to notice that all the food which plays any important part in the body is first converted into blood. The processes of digestion, absorption, and sanguification have this for their object, and it is unnecessary to consider them in detail here. It is in the blood that our inquiry practically commences. That the blood consists of two parts, corpuscles and liquor-sanguinis, is familiar to everybody, and it has been clearly demonstrated that the corpuscles are the main agents in animal oxidation, taking up oxygen in the lungs and giving it out again in the course of the circulation. Much of the oxidation so effected undoubtedly takes place in the blood, and to this oxidation is attributed by all physiologists a great part of the heat of the body. According to Liebig, it is non-nitrogenous substances only, substances derived from the starch, fat, and sugar of the food, which are oxidized in this way, and no work, but only heat can result from the oxidation. To the nitrogenous compounds of the blood, the albumen, fibrin, &c., he assigned the exclusive function of nourishing, or, as it were, repairing the solid tissues which are undoubtedly subject to incessant disintegration and decay as a condition of their life. He accordingly divided the constituents of food into respiratory and plastic elements, or, to use a simpler nomenclature, into "heat-givers" and "flesh-formers." This brilliant generalization has been adopted by the great majority of physiologists. There can be no doubt that nutritive matter does pass out through the thin walls of the capillaries and irrigate the neighbouring tissues. The cells, or elementary parts, of which a tissue consists, develop and grow at the expense of this nutritive fluid. When the cells have completed their term of life they decompose into simpler forms of matter, and pass back, together with the excess of the nutritive fluid, into the blood. This restoration to the blood is no doubt chiefly effected by the agency of the lymphatics, which take their origin, as recent anatomical research has shown, in the interspaces between the capillaries. In its passage through the lymphatic glands, all of the lymph that is susceptible of the process is reconverted into blood.

Closely connected with Liebig's food theory, is his theory of the origin of muscular work. The final result of the disintegration of muscular tissue is undoubtedly its oxidation; but Liebig assumed that this was the *immediate* result of it. He supposed, and it is still generally supposed by physiologists, that a portion of oxygen separated from its combination in the blood and traversed the walls of the capillaries with the nutritive fluid, and that as fast as the new cells were built up by the one, the old ones were oxidized by the other; the oxidized and now lifeless products being carried back to the blood to be ultimately excreted from the body as capable of no further use. The force liberated in this oxidation was the force which contracted the muscle, and so did the work. Lastly, it was assumed by Liebig that inasmuch as the muscular tissue was formed from the flesh-formers of the food, and was almost identical in composition with them, the whole work of the body was derived from the flesh-formers, which were therefore a true measure of the amount of work which the body could accomplish. When muscle, or the flesh-formers of food, are oxidized in the body, their nitrogen is chiefly converted into a crystalline substance called urea, the great bulk, if not the whole, of which is excreted through the kidneys. Hence the amount of urea excreted has been adopted by Haughton,* and subsequently by Playfair,† as a measure of the amount of work effected by the organism.

But these brilliant and beautiful theories encountered a certain amount of opposition even from the very first. Lawes and Gilbert, the well-known agricultural chemists, in describing some experiments on the fattening of cattle made twenty years ago, pointed out that the amount of urea which a pig excreted could be doubled merely by doubling the amount of nitrogen in its food, and this without any alteration in the quantity of work it did. Mayer, in a work‡ which will for ever remain a landmark in the history of science, combatted some portions of the theory with irresistible force, and more recently Voit in Germany and Dr. Edward Smith in England showed that the work of an animal could be enormously increased without any proportionate augmentation in the excretion of urea. This, with the important observation of Lawes and Gilbert, proved conclusively that the amount of work done could not be measured by the urea excreted. The theory which Mayer supported with such ability and which had indeed, as Frankland points out, been foreshadowed by that wonderful genius Dr. Mayow, of Bath, nearly 200 years ago, now began to revive, and Traube went so far as to argue that the oxidation of muscle, far from being the sole cause of muscular work, contributed nothing whatever to it, but that the whole of the work was done by the combustion of fats and hydrates of carbon (sugar, starch, &c.). Traube's calculations have been shown by Professor Donders, of Utrecht, to be inconclusive, but the same view has been recently maintained by two Swiss *savants*, Fick and Wislicenus, who endeavoured to establish it by a very remarkable experiment.* After abstaining for some hours from all food containing nitrogen, they weighed themselves with their accoutrements, and set out at day-break to ascend a neighbouring mountain, the Faulhorn. They ascertained the quantity of nitrogen excreted during and directly after the ascent, and calculated from it the amount of muscle, or other substance of similar composition, which must have been decomposed in the body to yield it. This was easy enough, for nitrogen constitutes about 15 per cent. of each of these substances. After applying certain necessary corrections, they found that the nitrogen indicated about 37 grammes of the dry muscle of each observer. They then proceeded to calculate the amount of force which could be produced by the oxidation of this quantity of muscle. Frankland has since determined this experimentally in the same manner as he did the force-value of food, and I therefore give his figures as being more reliable. He finds that it is 68,376 metre-kilogrammes; more than this amount of work could not possibly have been effected by the burning in the body of 37 grammes of muscle. What then was the actual work accomplished by the two experimenters? The mountain was 1,956 metres high. Fick weighed 66 kilogrammes and Wislicenus 76 kilogrammes, and these weights were raised to the top of the mountain. The work which each experimenter accomplished is therefore found by multiplying his weight by the height of the mountain. It is equal for:—

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* 'Dublin Quarterly Journal of Medical Science,' vol. xxviii. *et seq.*

† 'On the Food of Man, in relation to his Useful Work.'

‡ 'Die Organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel. Heilbronn,' 1845.

Fick, to	129,096 metre-kilogrammes.
Wislicenus, to	148,656 „

The oxidation of muscle therefore will not account for one-half of the actual work done, and if allowance be made for the work done by the heart and lungs, and for the fact demonstrated by Haidenhain, that the force developed is always at least double of that actually employed, the result of the experiment is even more striking.

One part of Liebig's theory, that, namely, which derives muscular work *exclusively* from muscular oxidation, must therefore be finally abandoned. This experiment has but supplied the finishing blow to what was already untenable; for, even apart from the researches already mentioned, Donders had, in a masterly essay published in 1864,* proved its insufficiency. Fick and Wislicenus indeed feel themselves justified in adopting the hypothesis of Traube, but this is not a necessary result of their experiment.

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* 'Philosophical Magazine,' June, 1866 (Supplement).

We have before us therefore two opposite views of the origin of muscular power. One has been already shown to be in its entirety untenable, but are we therefore to conclude, as Fick and Wislicenus have done, that the other is necessarily true? Most important consequences hinge upon the answer to the question, for if the view so long accepted be incorrect, all our notions of dietetics must be revised.

The first argument which is brought against the new hypothesis is founded upon common experience, which certainly seems to teach that a larger quantity of flesh-formers is necessary in the food when extra work is done. The superior strength of the British navvy is usually ascribed, not without probability, to the quantity of meat which he eats; and Donders sagaciously points to the case of the horse, which, as every one knows, may be fed upon grass when in idleness, but must be supplied with oats—a food richer in flesh-formers—if hard work is expected of him. Without assigning too high a value to arguments of this kind, it must be admitted that they are not destitute of force, and that it is somewhat difficult to answer them upon Traube's view.

But more cogent arguments are not wanting. In the first place, it is not literally true that muscular work produces no alteration in the amount of nitrogen excreted; on the contrary, a small though irregular increase is always noted, a fact which has been confirmed within the present year by some well conducted experiments of Dr. Parkes's.† It is indeed difficult, as Donders remarks, to imagine how it could be otherwise in many cases, for some animals may be fed, as Pettenkoffer and Voit fed a dog, and Savory, rats, upon food containing nothing but flesh-formers. In such cases the extra-work being done at the expense of nitrogenous food, must be attended with increased excretion of nitrogen. Moreover, it has been shown by numerous experimenters that the disintegration of muscular tissue is always increased by muscular work. Creatin, creatinine, lactic acid, and sugar, all of them products of the decomposition of muscle, have been found to be present in more than the usual quantity in a muscle which has been repeatedly contracted. Very nearly the whole of these substances are oxidized in the body into carbonic acid, water, and urea. It is therefore argued that the oxidation of muscle is as likely to contribute to the motive power of the muscle as that of the so-called respiratory elements of the food; and I find it impossible to dissent from this view. Ranke, in his splendid essay,* has indeed made use of these facts in support of the theory of Liebig, but valuable as his researches are, they can hardly be said to have made out his case. He proved that some of the products of the decomposition of muscle, and particularly lactic acid, had the power of hindering or even of arresting muscular movement. He found that the feeling of fatigue in an overworked muscle was mainly due to the accumulation of lactic acid in it; that it could be removed by washing out the lactic acid with water, and induced in a muscle which had been long at rest by the injection into it of a solution of lactic acid, or even of an aqueous decoction of a fatigued muscle! From these and numberless other experiments he argued that the amount of work done by an animal was nearly constant, unusual muscular exertion being always followed by a corresponding period of quiescence, which lasted until the products of disintegration were removed from the muscles, or neutralized. But his experiments, although extremely ingenious, were necessarily only of a qualitative kind, and cannot therefore be put in opposition to the direct quantitative proofs alleged upon the other side.

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* Translated in 'Dublin Quarterly Journal of Medical Science,' February and May, 1866.

† 'Proceedings of the Royal Society,' Jan. 1867.

But there is a third view of this great question which was clearly propounded by Mayer, but which seems to have been unaccountably neglected by later physiologists. It appears to me to afford a means of reconciling many of the difficulties which beset the subject. It is founded upon a consideration of the function which the blood fulfils in the matter. When blood traverses the capillaries of a muscle, it becomes darkened in colour. A portion of its colouring matter is reduced to the purple state, and at the same time some of the corpuscles disappear. During muscular contraction these changes are intensified, and the loosely combined oxygen of the colouring matter may even, as Ludwig and Sczelkow have found, be reduced to one-third of the average amount present during rest. Hence, muscular contraction is attended with a more rapid consumption of the oxygen of the corpuscle. According to the current theories we are therefore compelled to suppose that on the stimulus of the motor nerve, oxygen leaves its combination in the corpuscle, passes through, without combining with the easily oxidizible constituents of the liquor sanguinis, traverses the thin walls of the capillary in company with the outgoing nutritive fluid, and only exerts its force and produces oxidation when it is in contact with some comparatively distant muscle fibre. That this is the view usually taken by physiologists is shown by an incidental remark made by Dr. Bence Jones, in his address as President of the chemical section of the British Association at the last meeting.

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* Tetanus—Eine Physiologische Studie. Leipzig, 1865.

Alluding to one of Graham's recent discoveries, he said:—"The importance of this discovery in metallurgy, and its application to the physiology of respiration *and of the passage of oxygen from the blood into the textures*, must be apparent to all." But nothing could be more unlikely, on chemical grounds, than such a mode of oxidation. Oxygen, when just liberated from combination, is usually more active in entering into new combinations,* and yet, here we are called upon to believe that a great portion of it leaves one combination without any assignable cause, and remains for a time in a free state, although present in the same solution with matters for which it has a great affinity. That the oxygen of the colouring matter is capable of combining directly with some of the nitrogenous compounds of the blood, is evident from an experiment of Stokes's, in which a solution of blood was found to reduce itself when preserved in a closed vessel. The experiment further proves that the oxidizing power of the blood is not necessarily dependent upon nerve-action, although it may, very probably, be stimulated by it. Mayer saw this difficulty in the current theory of tissue-oxidation, and met it by placing the seat of all oxidation in the blood, and by assigning to the corpuscles the office of effecting directly the whole of it. Both heat and muscular work derive their source, according to him, from blood-oxidation, some portion of the oxidation yielding work, the remainder heat. He says, "The muscle produces mechanical work at the expense of the chemical action expended in its capillary vessels."

Claude Bernard seems to have adopted a similar view, and expresses it occasionally with great clearness. The following passage occurs in his celebrated 'Leçons sur les Liquides de l'Organisme:'†—

"Il est infiniment probable que l'acide carbonique du sang veineux résulte d'une oxydation qui s'est effectuée dans le globule sanguine lui-même. Lorsque le sang traverse les capillaires, il y aurait entre lui et les tissus non échange de gaz, mais peut-être échange de liquides. Par suite des conditions nouvelles que créerait cet échange, l'oxygène du globule serait en partie employé à oxyder le carbone du globule lui-même."

This therefore is the third, and it appears to me the only tenable hypothesis of the source of muscular power. I shall speak of it as Mayer's hypothesis. The blood is the seat of all oxidation, and therefore the originator of all force in the body. Some part of this force is evolved in the form of muscular work, the greater part of the remainder in that of heat. How it comes about that oxidation inside a capillary is converted into muscular movement outside, we do not know with certainty. The conversion is effected under the control of the nervous system, and we may therefore venture to suppose that some of the force set free during blood-oxidation may, through the agency of the nerves, take the form of electric currents, which are the direct agents in the muscular work. This, however, is little better than a guess, and as such is entitled to very little reliance. The function of the nerves is the most obscure of all physiological problems, and the difficulty which it presents in this particular hypothesis is not greater than that which enshrouds all others on the subject.

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* It is, however, right to add, that oxygen is probably held in cruorine, in what Kekulé calls "molecular combination," since it has been shown that carbonic oxide displaces from it its own volume of oxygen. In this case the liberated oxygen would not be more than usually active.

† Vol. i., 342.

The establishment of Mayer's hypothesis would of course render meaningless the controversy between the followers of Liebig and those of Traube, for as both fats and carbohydrates on the one side, and the products of muscle metamorphosis on the other, are oxidized in the blood, both may equally be supposed to be originators of muscular power. It becomes therefore a matter of the utmost importance to test Mayer's view by every means we possess. I think it is possible, by an extension of one of his own lines of argument, to approach very near to a demonstration of its truth. He pointed out that the fluid which passed out from the blood through the walls of the capillaries was afterwards returned to the blood through the lymphatics, and that the quantity of this exudate could therefore be measured by the quantity of lymph. In this way he calculated that not one per cent. of the blood left the blood vessels in the course of the circulation, and he therefore inferred that not less than 99-100ths of the total oxidation of the body must be affected inside the blood vessels. But this argument is not entirely satisfactory, for it might be objected that the exudate, small though it was in amount, carried with it a sufficient quantity of oxygen for the oxidation, and therefore for the work of the muscles. I have therefore suggested another, which appears to me much more convincing. I purposely exaggerate every element of the calculation, in order as far as possible to overstate the case against me.

The first thing to be done is to estimate the extreme quantity of fluid which can be supposed to exude through the walls of the blood-vessels in twenty-four hours. We have better data for this purpose than Mayer possessed. Bidder and Schmidt estimate the quantity of lymph and chyle together daily added to the blood at 28¾ lbs. Of this 6½ lbs. is chyle, which comes from the food, and may be left out of the calculation. But I will assume the quantity of lymph alone to be 30 lbs. It may be objected that some of the exudate may return directly to the capillaries without traversing the lymphatic system. If this be the case, the quantity so returned could not be large, as the blood flows at a considerable pressure—a pressure which would tend to prevent such a return. Nevertheless, I will, on this supposition, double the amount already given, and take it at 60 lbs. A large proportion of this would arise from glands and other parts which do little or no muscular work; but this I neglect. Finally, it may be urged that some portion of the exudate may escape as perspiration without returning to the blood at all. I therefore add 6 lbs. to obviate this source of error, and thus get a total daily exudate of 66 lbs. or 30 kilogrammes, an amount which I think every physiologist will admit is an extreme overstatement.

How much oxygen can possibly be supposed to pass out in solution in this 30 kilogrammes of exudate? Berzelius found that the serum of blood would not dissolve more oxygen than water would. This would give as the quantity of oxygen exuded in 24 hours, less than 1½ grammes; but I will assume that the exudate will dissolve 20 times as much oxygen as this, in fact, that it will absorb more than the moist corpuscles of the blood of the portal vein, which are superior to all others in this respect. The estimate is so extravagant that it is almost absurd to make it. It gives, as the daily exudate of oxygen through the muscles, 25·74 grammes. If the work of the muscles is done by oxidation *outside* the walls of the capillaries, it must all be done by this quantity of oxygen, and it is easy to show that the quantity is entirely insufficient for the purpose, whether it were employed in the oxidation of muscle or of fat.

25·74 grammes of oxygen would oxidize 17·31 grammes of muscle, and thus yield a force of 31,210 metre-kilogrammes, or 8·87 grammes of fat, and thus yield a force 34,070 metre-kilogrammes.

To compare with this I will give an extremely low estimate of the work accomplished in the body in 24 hours, omitting doubtful items:—

	Metre-kilogrammes.
Work of the heart (Donders) . . .	70,000
Work of the lungs	10,000
Work of the muscles	20,000
	100,000

The force actually generated to effect this work must, as Haidenhain has shown, be at least double the above quantity, so that even upon this extravagant calculation, the oxygen, which may be supposed to pass out from the capillaries to the muscular tissues, can only account for about one-sixth of the work done by the muscles.

The establishment of Mayer's hypothesis would unfortunately not help us much in the solution of the practical question, What kind of food is most suitable for the man who does hard work? Both flesh-formers and heat-givers are available for the purpose, and provided the former are sufficient to repair the daily waste of the tissues, it is possibly immaterial which is employed. Even this, however, is not certain, and as we are still ignorant of the exact relation which tissue disintegration bears to work, we cannot as yet pretend to determine *à priori* the quantity of flesh-formers necessary under conditions of work. The practical solution which experience has provided for the problem must for the present rule our dietary scales, although it can hardly be doubted that a more scientific knowledge upon the subject will before long be gained.

IV. LIGHT AND DARKNESS.

Winslow on Light.*—Johns on the Blind.†

Regarding the nature of Light, there have been, and perhaps may still be said to be, two distinct theories extant. The older view conceives of light as a form of matter, infinitely diffused, but still *matter*, which is itself projected from the light-emitting body, and falls upon the surrounding objects; the newer theory treats light as a force, and necessitates the belief in an interplanetary Ether, also a form of matter infinitely attenuated, but capable of being agitated in waves by the luminous force. The latter or undulatory theory of light, which makes it to be a mode of motion, is now almost completely established, and although the human mind cannot yet form a proper conception of the interplanetary ether, the medium acted upon, still that may be said also to be one of the acknowledged facts of physical science.

Around this subject cluster many eminent reputations; that of Newton stands out the most prominent; it was he who first analyzed a ray, and showed it to be far more complicated than it appeared to be without the intervention of the prism. The elder Herschel and Ritter revealed the character of the non-luminous but calorific, and chemical, or as Robert Hunt has called them, the Actinic Rays. Stokes, Hunt, Locke, Joule, Balfour Stewart, Tyndall, and many others, have added to our knowledge of the nature and effect of light; and yet that knowledge is but in its infancy.

Wonderful as are the operations of light upon inanimate nature, operations which have caused it to be employed in photography to perpetuate the memory of the living and to recall most vividly the history of the past; still more wonderful is its influence upon living forms, whether in the animal or plant world.

* 'Light—its Influence on Life and Health.' By Forbes Winslow, M.D., D.C.L., Oxon. Longmans.

† 'Blind People: their Works and Ways, with Sketches of the Lives of Some Famous Blind Men.' By Rev. B. G. Johns, M.A., Chaplain of the Blind School, St. George's Fields. Illustrated. John Murray.

Its absence or presence causes marked modifications, not only in the colours of plants, but in their growth. It attracts vegetable forms or parts of them in the most extraordinary manner, and with recurring regularity. A wonderful sight, well known to microscopists, is that of the little volvox-globator, gathered in a green mass towards the light when some water containing these exquisite forms is exposed to its influence. Every child has watched the sunflower as its great round face is turned, as though by some machinery within, and follows the orb of day in its course through the heavens; and does not the gastronomic epicure well know that his asparagus, if carefully bedded up and kept in darkness, will not have the green hue which it assumes as soon as its head peeps above the soil?

And as to men and animals, we have only to look at the stunted creatures of the dark and cold regions of the world; or at those who are bred underground or in the dismal courts of large cities in our own temperate zone, to be satisfied that with light we have robust, strong, and well-developed bodies; and without it, the reverse of these qualities.

As we have already stated, the undulatory theory of light is now the accepted theory; and although the *nature* of the interplanetary ether which fills all space is a matter of individual conception, yet the presence of some such medium must be recognized along with the dynamic theory. And when we come to consider the nature of those material forms and organizations which must be permeated by that infinitely attenuated form of matter before light can penetrate them, and compare some of the transparent solids with fluids or gases which are only partially translucent, we become still more puzzled to understand the character of the medium upon which the force acts that we term light. The arrangement of the atoms which exclude it from one portion of our precious organ of sight, and concentrate it in another, are truly marvellous, and sad indeed is the fate of the creature in whom the natural order of the parts is so disturbed, that whilst all is bright, heavenly, smiling light without, there is nought but gloom and darkness within.

Dr. Winslow tells us but little worth remembering, and almost nothing that is new, concerning the physiological effect of Light, and sums up his information upon that portion of the subject with which we should have supposed him to be the best acquainted (namely, the influence of light upon the insane), with the admission that he knows little or nothing about it, and in these words, "I freely admit that placing but little faith in what has been recorded or said on the subject, I have not kept any systematic register as to the effect of different phases of the moon on the insane."*

Of the modern theories of light we take him to be ignorant, for whilst we have to wade through page after page of valueless gossip as to what men in semi-civilized ages believed concerning its nature and influences, we are told in a brief sentence that "it would be irrelevant to enter into the discussion of the varied theories of light that have been propounded."* With the science of Zoology, too, the author seems to be but little better acquainted, and nothing is more annoying than to find, that as soon as he approaches a portion of his subject at all likely to be interesting, he dismisses it with some passing remark, which shows that he has never given the question a serious thought or is unable to deal with it from recent information. Indeed, it would have been better for the author's reputation if he had left this work unpublished; and before he sits down again and attempts to deal with a subject of such vast importance, we should recommend him to keep a diary of his personal observations, which would be sure to be interesting and valuable, instead of putting together a mass of useless information, which commences with nothing and ends as it begins.

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* P. 233.

But of Mr. Johns's book we can speak in a widely different tone.

He tells us honestly what is the real effect of darkness upon the minds of those who are deprived of sight. Every line he has printed is suggestive and full of meaning, and to many a seeing reader, his story of the blind, their works and ways, will give fresh light and impart new sympathies.

Some persons may be disposed to think that the honest estimate which he gives us of the mental and moral qualities of the blind, might to some extent withdraw public sympathy from them, but that will by no means be the case. He shows indeed that they are apt through neglect or indulgence to become selfish, suspicious, and irreverent; that a human being born blind can never attain the mental standard which he would reach if he had received all his senses; but these facts (which apply equally to the deaf and dumb) in no-way lessen the responsibility of those to whose care the blind are entrusted; quite the reverse; if it has pleased Providence to deprive them of a certain sense, and place them in a position of inferiority in that respect, it becomes the duty of those who can see, to use every possible expedient for supplying the place of the missing sense, and to keep the patient clear of those quicksands, to which the loss of eyesight exposes him.

The author's account of the progress of a blind boy under instruction is deeply interesting. When he first enters the Asylum or School,—

"It is all so utterly new and strange to him, that for the first day or two he is entirely dependent upon some pupil's or teacher's hand to get as far as the school-room, the chapel, dining-room, or basket-shop, all of which are widely apart, but first impressions with the blind are all in all, and within the week the chances are that out of his 80 blind fellow-pupils he has chosen one as a companion and probably his friend, and for several years to come, who, if need be, conveys him across the open yard to any special point; to the dormitory or through the more intricate navigation of staircase leading to the band-room. In a month all the plain sailing is fairly mastered. He can find his way from the dining-room to the basket-shop, and down that shop 150 yards long, just to the very site of his own box, on which he sits to split the withies for basket-work. He knows his own box, too, from Smith's and Brown's on either side of him. In a year he will know probably his own tools from theirs by some little flaw or feature, not patent to the eye of the looker-on; in a couple of years he will know the handle of the door to music-room, No. 5 from that of No. 6; he will run quickly with a half-finished basket in his hand from the workshop, across a wide yard, exactly to the very door-step of the open shed in which is a tank for soaking his willow-work."*

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* P. 3.

Of his touch, the author says:—"By it he knows his own clothes and almost all the property he possesses: his tools, box, bed, hat, fiddle, cupboard, seat in chapel, school-room, and workshop; by it he reads his chapter in St. John and Robinson Crusoe; he plays chess or dominoes, works a sum in long division, or writes a letter home to his mother, which she can read with her eyes and he with his fingers. By the help of touch he weaves a rug of coloured wools, embracing every variety of scroll-work or of those peculiar flowers and fruits which grow only on carpet-land; or fringes with delicate green and red; a door-mat for a lady's boudoir; by touch he *sees* any curiosity, such as a lamp from the Pyramids, or a scrap of mineral which you describe to him, and which, having once handled, he always speaks of as having seen. He *thinks* he can read a good deal of your character by touch when you shake hands with him; and when he has heard you talk for a few minutes he will make a good guess at your age, temper, ability, and stature. "Saunderson" (a blind mathematician whose history the author gives in another chapter) "at times guessed even more than this. He had been sitting one day and pleasantly chatting with some visitors for an hour, when one of them wished the company good morning and left the room. 'What white teeth that lady has,' said the sarcastic professor. 'How can you possibly tell that?' said a friend. 'Because,' was the ready answer, 'for the last half-hour she has done nothing but laugh.'"†

The author describes with equal vivacity and effect the various employments of the blind. How they work arithmetic; emboss letters; weave; play chess; write poetry; the latter he believes that those born blind can never do with full effect, for their conceptions of external nature must be erroneous, and he shows that their verses are rather high-flown than poetical.

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* P. 9 and 10. † P. 11 and 12.

As regards the infidelity of Saunderson, the blind mathematician; we think that the author, who is an orthodox clergyman, takes an erroneous view of it. There are many considerations which have not occurred to him, and he judges not only the blind mathematician, but also other blind people somewhat incorrectly in this respect.

In the first place, if the mathematician had *seen* he might have been just as great a sceptic; we know mathematicians who require mathematical proofs of everything. Now Saunderson did believe in the "God of Newton."* Again, he tells us† that he "fell into excess in matters of drink;" and was naturally morose and sarcastic. Should he then judge other blind people by such a standard, or attribute Saunderson's scepticism to his blindness? Is he aware that in his description of the habits and character of the blind, he is himself sometimes a little hard? He must see great contrasts, too; a trust far more implicit than those can have who *see* as well as think; and which presents in greater contrast the scepticism which he believes to be exaggerated by physical darkness. But these are trifling faults in his admirable book.

We quite agree with the author concerning the form of embossed type to be employed. It should "resemble as nearly as possible the type in use amongst seeing men, that the blind scholar in learning to read may have every possible help from the remembrance of letters he *may* once have *seen*, but which now his fingers must feel for him, or from any one who can read an ordinary book, or if need be, that a friend may read to him.‡ The words must be *correctly* spelt in full" (not phonetically written, as in some systems in use among the blind), "that when he learns to write, others may read his written words;" and all should be clear and well defined, that his hardened fingers may easily trace the letters.§

The author cites some wonderful instances of retentive memory among the blind:—"Miss Walker, who had mastered five languages and knew all the Psalms and New Testament by heart," and a young man now in the school in St. George's Fields, "who can repeat not only the whole of the 150 prayer-book psalms, and a large number of metrical psalms and hymns, as well as a considerable amount of modern poetry, including Goldsmith's 'Deserted Village,' but—incredible as it may seem—the whole of Milton's 'Paradise Lost,' with marginal notes and a biography.‖

In addition to a large amount of valuable statistical information, the author gives us some useful hints as to the causes of blindness, and we can well believe that "two of its stanchest allies" are "typhus and scarlet fever."

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* P. 53. † P. 178.

‡ There appears to be some clerical error here.

§ P. 117. ‖ P. 65.

Here comes another piercing cry on behalf of the poor which reaches to our inmost souls; a cry for pure air; pure water; light; roomy and cleanly dwellings; and a blow at that great curse of our day, the gin-shop! Ask, What is the cause of deafness? and you will hear, Scarlet fever and typhus. Whence arises blindness? again, "Scarlet fever and typhus." Epilepsy? "Typhus." Insanity? "Typhus." Ask again, Whence comes scarlet fever and typhus? and the answers are, "Drunkenness; overcrowding; filth; impure water; impure air!" When will men turn their *earnest* thoughts to "reform bills" for the cure of these evils?

Mr. Johns gives some short but interesting biographies of blind men; of Huber, the well-known blind naturalist; Metcalf, the road-maker; Stanley, the musician; Saunderson, the mathematician. He also tells some humorous anecdotes of blind tramps and beggars; and gives a poetical account of a visit of Mendelssohn to the Blind School at Zurich:—

"He was there in the hot summer of 1842 to rest and recruit his overtaxed brain, and though besieged by a crowd of eager musicians and amateurs, would accept of no invitation. But hearing that the pupils of the Blind School were most anxious, as *they* said, to see him, in their favour he made an exception. He spoke to the sightless assembly in kindest words; he listened to their songs and choruses, and score in hand, to some even of their own compositions, showing clearly his interest and pleasure. Seeing a correction on the score, and finding it to be the blind musician's own work, 'It is right,' he kindly said, 'and makes the passage more correct, but it was better and more striking before; take care that your corrections are improvements—a cultivated ear wants no rules, but is its own rule and measure.' And then the great musician asked permission to sit down at their piano, and wandered away into one of those wild and tender strains of speaking melody for which he was so famous. His silent, wrapt audience listened so intently to the 'song without words,' that a pin-fall would have broken the stillness. One by one, over the eager faces, crept the air of deep, quiet joy, until in the midst of the great flood of mingling harmonies, a voice came to them out of the very chorus they had just been singing. Then their enthusiasm knew no bounds. The great master had carried them away at his will, to heights of joy and triumphant praise before unknown; he had whispered to them of sorrow, and the cloudy ways of life, in words of soft unbroken tenderness; and now he stirred their inmost depths by a strain of their own weaving, into which he poured a new tide of living song, new grace, and new meaning. No words could tell what they felt; they could have pressed him to their very hearts for joy. This was not long before the great musician's death; but he still lives in the Blind School at Zurich, and there still remains, as a precious relic, the master's chair in which he sat."*

With this extract we close Mr. Johns's book; and we must admit that having opened it with a critic's eye, and with the reviewer's thoughts, as we advanced in its perusal we were more and more sorely tempted to "cut it up," and to transfer the rich and fertile "cuttings" bodily into the pages of this Journal. But that would not have been fair to the author, and we hope that the lengthy extracts which we have been led to insert, along with the excellent illustrations, which we can *not* give, will do something towards securing for the author that large circle of readers to which his honest, truthful, and poetical descriptions of the works and ways of the blind are justly entitled.

V. THE SYSTEMATIC STUDY OT ANNELIDS.

1. Johnston: *Catalogue of Worms* (*Brit. Mus.*), 1865.
2. Kinberg: *Eugenies Resa* (Aproditea), 1857.
3. Schmarda: *Neue wirbellose Thiere.* 1861.
4. Ehlers: *Die Borstenwürmer* (*1st Part*), 1864.
5. Malmgren: *Nordiska Hafs-Annulater*, 1865.
6. De Quatrefages: *Annélides et Géphyriens*, 1865.
7. Malmgren: *Annulata Polychæta Spetsbergiæ, Grœnlandiæ, Islandiæ, et Scandinaviæ*, 1867.

There can be little doubt that human knowledge and science have hitherto presented, and will continue to present, the same order of evolution as other progressive phenomena. We trace it from the simple to the complex, from the general to the special; but most markedly and distinctly has it progressed from the comprehension of plain and obvious facts and appearances, to that of less plain and less obvious phenomena. Small though the illustration may be, yet it is worth remarking that the various phases through which the study of systematic zoology has passed, furnish a very clear instance of this progress. Omitting the classification of Aristotle—which was far in advance of the philosophy of the contemporaries or disciples of that marvellous man—we must start with Linnæus, as the father of modern Zoology. Of invertebrate animals, he only distinguished two great groups, his Insecta and his Vermes, the latter being a heterogeneous assemblage of all the creatures whose characters were less *obvious* than those of the former. Cuvier separated the Molluscs and Ringed-worms from this group when he gave to the world his fourfold division of the animal kingdom; but these same

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* P. 99 to 101.

Ringed-worms and his Radiata were obscure groups, and the former have up to the latest years been badly treated. Whilst Linné's Insecta have been everywhere studied and ardently collected, whilst shell collectors and conchologists flourish in every small town and village, and over thirty pounds is not unfrequently given for some rare *Cypræa*, but few men are to be found who would hunt out worms from their secret retreats, or keep a collection of their beautiful forms preserved in spirit. Linné himself knew the characteristics of but very few worms, and only made five genera of Annelids (properly so called), making thus a much smaller advance upon his predecessors than in the case of Insects and Molluscs.

The reason of this is to be found in the general obscurity surrounding these animals; not only are they obscure in their habits, hiding deep in sand and mud, lurking under stones or in the cracks of rocks, but the differences which separate them specifically and generically from one another are not at all obvious, nearly all conforming to two or three types of general shape and appearance, whilst many are minute and fragile. Add to this that they can only be preserved in spirits or similar fluids, and the list of difficulties is complete. By some of the authors, the title of whose works we have placed at the head of this article, the microscope has been used most successfully in finding sure characters by which many species can be distinguished; and under the auspices of MM. Kinberg, Malmgren, and Ehlers, the study of Annelids is assuming a character of certainty and definiteness which cannot fail to attract new workers. Nothing can be more beautiful of its sort than a collection of Annelids preserved in spirits, many having the most gorgeous hues and most graceful forms; surely it will not be long before we have numerous collectors and devotees of worms, who will of course call themselves Annelidologists or Scolecologists, or by some other equally euphonious title.

We wish here briefly to point out the structures which are made use of in arranging Annelids and determining their species by M. Malmgren and his colleagues, leaving aside the general anatomy and physiology of the group, in which there is very much yet to be learnt and done.

The term "Annelids" does not convey to the mind of every naturalist the same meaning; and it is as well, perhaps, to settle upon some one of the limitations of the group given by various writers. Cuvier's Annelids included the marine bristle-bearing worms, the earth and fresh-water worms, and the leeches. Lamarck, Savigny, and others included with these that curious group of animals connecting the Worms and Echinoderms—the Gephyrea. Dr. Johnston, again, embraces in his group of Annelids the soft, ciliated, ringless Turbellaria, whilst MM. Van Beneden and Gervais turn out the Leeches and admit the Gephyrea. For the student of species and their general superficial relations, there can be no doubt that Ehlers' group of Chætopoda, embracing the marine and fresh-water bristle-bearing worms (Borstenwürmer), the Polychæta and the Oligochæta of Grube—to the exclusion of Leeches, Gephyriens, Turbellarians, and such-like doubtful orders—forms a very convenient and well-limited field of work.

Understanding thus, then, the term Annelids, let us see what striking characteristics they present in common. In the first place, the body is composed of a series of more or less similar rings, from which in all, a single or double series of horny bristles or hooklets is developed on each side of the body. In the marine Chætopods a soft appendage, or "foot," is also developed on each side of most of the rings, and three or perhaps more of these rings coalesce to form a head, which in many cases is very highly organized. In the earth and fresh-water Chætopods, on the other hand, no foot is ever developed, and the head consequently has a quite simple form, destitute of any tactile or sensory appendages. The modifications of the head and feet (in those species possessing them) and the form of the bristles or setæ, which require a microscope of high power for their examination, are the characters which are available for generic, specific, and other divisions. It would be impossible here to run through the whole group of Chætopods, which embraces now many hundreds of species; we may, however, take one or two examples from Dr. Malmgren's last published work.

The genus *Aphrodita,* into which Linné threw all the scale-bearing Annelids he knew, has been gradually broken up into nearly thirty genera, grouped in four families. We have selected two common species belonging to the same family, Polynoïna, but to different genera, for illustration: the one is the *Lepidonotus squamatus,* the other the *Harmothoë imbricata;* they are both about an inch-and-a-half in length, and frequent the same habitats, *viz.* the under-surfaces of rocks and stones within tide-mark. These two forms and the species allied to each were, till the observations of Kinberg, kept in one genus, *Lepidonotus,* as defined by Leach. In Figs. 1 and 2 the heads of these two worms are drawn very carefully on an enlarged scale. In each there is a more or less bifid cephalic lobe, carrying two pairs of eyes, and connected with a median tentacle, *pt.*, a pair of antennæ, *a.*, a pair of palpi *P.*, and two pairs of tentacular or peristomial cirri, *p.c.* These parts and their bases are all disposed around the cephalic lobe, and form the head; but in *Lepidonotus,* the antennæ arise from the tips of the cephalic lobe, whilst in *Harmothoë* they spring from the base of the median tentacle. A further very concise difference is exhibited by the setæ fixed in the soft feet, which are broader and more deeply serrated in one than the other (Figs. 5, 6, 9, 10). The foot differs in each a little also in the proportion of its parts. It is an example of that sort of foot which is divisible into two branches, a notopodium and a neuropodium (Figs. 7 and 8, *nto. nre.*), each of these two parts carrying a cylindrical appendage or cirrus and its bunch of setæ. The notopodial cirri in the two figures differ considerably, resembling the peristomial cirri: they are smooth in *Lepidonotus*, but carry short papillose hairs in *Harmothoë*. The group to which the Polynoïna belong is remarkable for having flat scale-like bodies covering the back, placed in pairs on the alternate rings, or, as in the Sigalionina, on nearly every ring. The scales are in many species very beautiful objects, and furnish very important means of distinguishing forms. In the genus *Lepidonotus* there are only twelve pairs, and these adhere firmly to their attachment; in *Harmothoë* there are fifteen, or sometimes, twenty pairs, which very readily slip off from the body. In Figs. 3, 4, the scales of the forms we are noticing are drawn. Those of *H. imbricata* exhibit the greatest variation in colour, being brown, black, purple, yellow, or mottled with these colours.

Let us glance now at another very different-looking group of Annelids. The Nereids are long snake-like worms, often attaining a length of ten or twelve inches. In the plate, the head of *Nereis pelagica* and some of its setæ and a foot are drawn (Figs. 11, 12, 13), the parts homologous with those of the Polynoïna just described are similarly lettered. The very characteristic form of the setæ is of great value in grouping the species of this family as well as the lobation of the feet.

The suppression or modification of the parts of the foot and their homologues attached to the head, constitute the essential differences of the various tribes of marine worms. In some, the rings immediately succeeding the head differ from the most posterior in the form and character of their appendages; in most of these the appendages of the head are curiously modified so as to form long filamentous branchiæ, Fig. 15, and sometimes also in tubicolous species an "operculum" which closes the tube in which they live. The greater or less development of a thoracic region has thus led to the division of marine Chætopods into two principal groups, the Errant and the Sedentary, the latter group comprising those in which the thoracic region is present; a third group is sometimes distinguished which bear a superficial resemblance to the earth-worms, and have been, by some writers, associated with the Sedentary, by others with the Errant forms. The modifications of the foot and its appendages are the most remarkable in the Errant group, whilst the head exhibits the greatest peculiarities in the Sedentariæ. In *Phyllodoce* (an errant genus) the notopodial cirrus has the form of a large leaf-shaped appendage; the rings forming the animal being very numerous, there are often more than a hundred pairs of the appendages, frequently brilliantly coloured, with which the animal rows itself through the water. In *Eunice, Nerine*, and *Arenicola* branchial filaments are developed in connection with the foot, in which the red fluid of the worm circulates. In *Syllis* the cirri are very long and moniliform, attaining in a kindred genus, *Guttiola*, a length considerably greater than that of the worm's body, to which they seem attached like so many Gorgon's locks. In *Polyopthalmus* an eye is developed on each foot. The further modification of these parts leads to very numerous minor generic divisions, all resting mainly upon differences in the form of the appendages and setæ of the foot, and only to be discovered by attentive and careful examination with the microscope.

Various forms of setæ are drawn in Figs. 14, 16, 17, 18, belonging respectively to Sabellaria, Praxilla, Leprea, and Leucodore, and all equally characteristic of the genera and species to which they belong.

The Oligochæta (fresh-water worms) have not received even as much attention as the Polychæta (the marine), and indeed this is not surprising, for without the use of a microscope applied to the setæ, it is impossible to distinguish some of the species with any certainty. Much has yet to be done with this group of Annelids; for it has not at present been touched upon by Kinberg, Ehlers, or Malmgren. The setæ are fewer in number in this group (whence its name) than in the one we first looked at, and there are no appendages in the form of feet; hence the setæ become of still greater importance to the zoologist.

In some species (*Tubifex*) the setæ are hair-like bodies; in others they are stout and short (*Lumbricus, Phreorycles*), Fig. 20, 21; in others again they have a bifid apex (*Chætogaster*), Fig. 24; or this sort of setæ may be associated with other hair-like ones (*Clitellio*, &c.), Figs. 22 and 23; in *Ctenodrilus* the setæ are pectinated, Fig. 25.

There are many species of Oligochæta, though the group is far less numerous than the Polychæta. They are to be found in moist earth, in the ooze of streams and rivers, and in sandy soils also. Some writers contend that no Oligochæta are marine, whilst it is certain that no Polychæta are fresh-water or terrestrial.

The geographical distribution of Chætopods is a matter of which very little is known, Schmarda's and Kinberg's works being the principal sources of information, whilst M. de Quatrefage's volumes contain figures and descriptions of many foreign species. It appears that very many genera are cosmopolitan and apparently some species; but on this matter we must hope for sounder information when we have students of Annelids as ardent and numerous as our entomologists, ornithologists, and other specialists.

The study of the development and anatomy of the Chætopods does not belong to the specialist, and whilst it no doubt has a higher importance than the mere recognition of specific differences, cannot supersede such work. There are many men whose minds are so moulded that the power of investigating anatomical and embryological structures does not belong to them, whilst they may possess the most acute perception of specific differences of form and exhibit great patience and skill in the collection and arrangement of specimens. There are other men who have no sympathy with the accumulators of species, and see but little value in such work, devoting themselves rather to anatomical and physiological researches. There is work for both classes of zoologists, both are valuable labourers; for men combining the powers of the two are few and far between. It is to the first class that we look for an extended knowledge of the Annelida; we believe we have shown that there is a wide but well-defined field of study in the Chætopodous Annelids—and trust that some fresh workers may be induced to enter on it.

One word remains to be said with regard to each of the books in particular, the names of which stand at the head of this article.

We must warn intending "scolecologists" against the 'British Museum Catalogue of Worms,' which is very far indeed behind its time, and will be of but little use. It would be unjust to blame Dr. Baird for this, whose name stands as editor. The work is really the old notes accumulated during many years by Dr. Johnston, and was almost in its present condition ten years since, when it was quite up to the time. Grube's researches on, and classification of, Annelida, have since become everywhere recognized, and now the Catalogue can only be found useful as furnishing a list of localities and some few observations on habits, colour, &c., by that very excellent observer, the late Dr. Johnston.

Kinberg's work on the *Aphroditea*, collected by the exploring ship 'Eugénie,' is of great value, since it is written in Latin, contains the definitions of many new genera and species, and is well illustrated.

Schmarda's work contains descriptions and coloured illustrations of a great number of species from all parts of the world.

Ehlers' Borstenwürmer promises to be a most complete and valuable work as far as the characters of genera are concerned. The large, finely drawn plates are among the most beautiful we have seen. The work is, however, chiefly interesting to the anatomist.

In 1865, A. J. Malmgren, one of the indefatigable Scandinavian zoologists who number amongst them Sars, Loven, Steenstrup, Lilljeborg, Kroyer, and Kinberg, published the first part of a work on the North Sea Annelids (5), which will be of the greatest value to the English Student. The descriptions, localities, and such matters are given in Latin, and hence ignorance of the Swedish tongue need not deter any one from using the book. The part already issued contains the species belonging to the Aphroditacea, Polynoïnia, Acoetea, Sigalionina, Phyllodocea, Nephthydea, and Lycoridea, illustrated with detailed drawings of the heads, setæ, feet, and other appendages, executed with great care. We have also received from Dr. Malmgren an illustrated Catalogue of the northern Annelids in the Stockholm Museum, in which many additional species are figured, and some valuable remarks on the species in the British Museum collection examined by him, are given. The synonymy of species, which is always a troublesome matter, is unusually perplexing in the Annelids, and Dr. Malmgren has devoted great pains and research to setting it on a right basis.

The brilliantly illustrated volumes published by M. de Quatrefages in 1865 will be found very useful. They contain most excellent chapters on the anatomy and general natural history of the class, and descriptions of many species. The absence of figures of many of the new species renders them rather obscure. M. de Quatrefages has not consented to the minute generic divisions of some of his contemporaries, and indeed we venture to think Dr. Malmgren has carried this method of arrangement a little too far; in the family Polynoina, the genera proposed by Kinberg seem to us sufficiently minute—they were six in number; but Dr. Malmgren is not content with less than seventeen.

A work on the British Annelids and Turbellarians is promised by the Ray Society. Dr. McIntosh is the gentleman who has undertaken this gigantic task, and he really needs all the help that can be given to him by local and other naturalists. Specimens and coloured drawings from life are the only way in which this help can be given, and we trust that Dr. McIntosh may not long have to grapple with the Annelids single-handed.

EXPLANATION OF THE PLATE.

Fig. 1. Head of *Lepidonotus squamatus*, after Kinberg; *L.* cephalic lobe; *pt.* prostomial tentacle; *a.* antennæ; *P.* palpi; *p. c.* peristomial cirri.
Fig. 2. Head of *Harmothoë imbricata*, after Malmgren; letters as in Fig. 1.
Fig. 3. Elytron of *Lepidonotus squamatus.*
Fig. 4. Elytron of *Harmothoë imbricata.*
Fig. 5. Notopodial seta of *L. squamatus.*
Fig. 6. Neuropodial „ „
Fig. 7. Foot and appendages of *L. squamatus.* *nto.* notopodial cirrus; *nrc.* neuropodial cirrus; *s.* setæ.
Fig. 8. Foot of *H. imbricata;* letters as in Fig. 7.
Fig. 9. Notopodial seta of *H. imbricata.*
Fig. 10. Neuropodial seta „ „
Fig. 11. Notopodial seta of *Nereis plagica* (after Malmgren).
Fig. 12. Head of *Nereis pelagica;* letters as in Fig. 1.
Fig. 13. Foot of *N. pelagica;* letters as in Fig. 7.
Fig. 14. Seta of *Sabellaria spinulosa* (Malmgren).
Fig. 15. Head of *Chone Duneri* (Malmgren).
Fig. 16. Seta of *Praxilla gracilis* (Malmgren).
Fig. 17. Seta of *Leprea textrix* (Malmgren).
Fig. 18. Seta of *Leucodore ciliata.*
Fig. 19. Head of *Clitellio arenarius.*
Fig. 20. Seta of *Phreoryctes Menkianus.*
Fig. 21. Seta of *umbricus terrestris.*

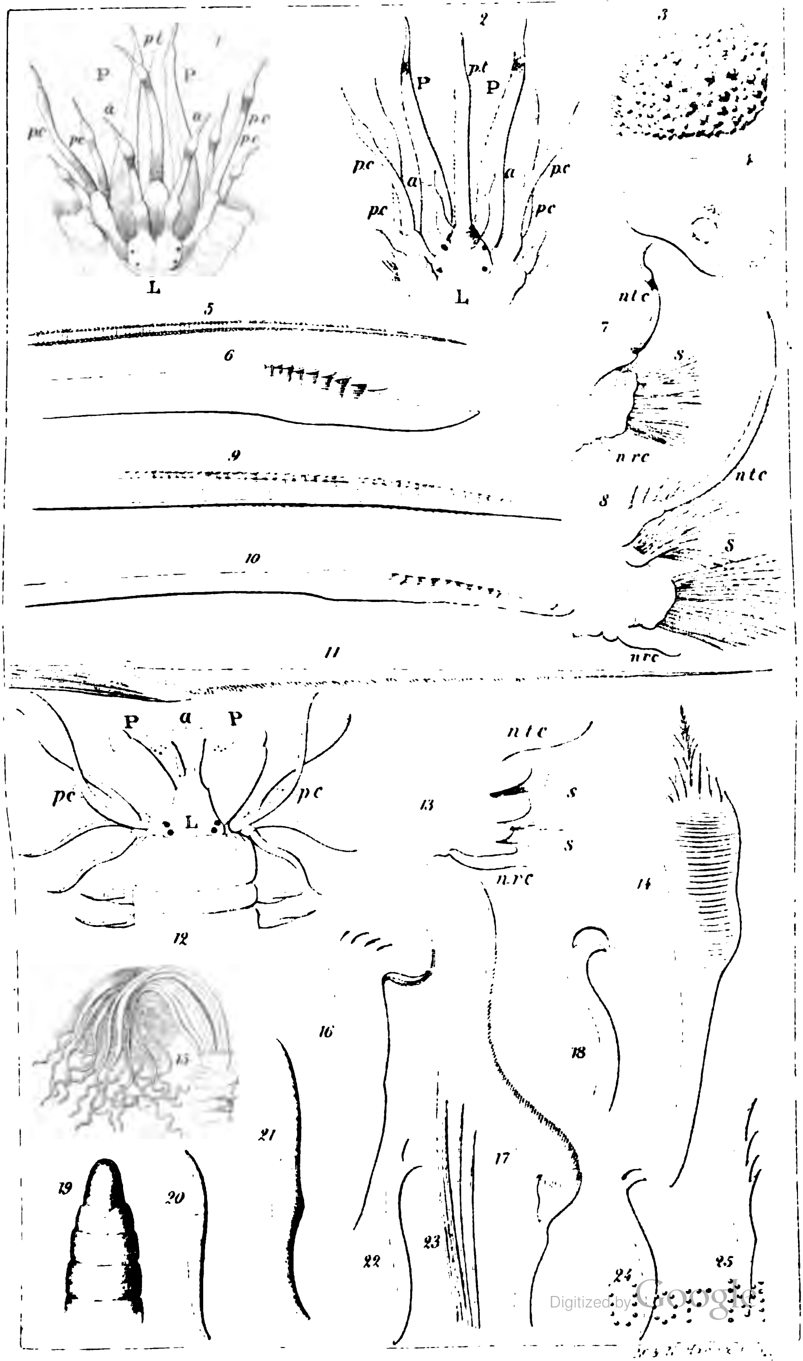
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Fig. 22. }
Fig. 23. } Seta of *Clitellio.*
Fig. 24. Seta of *Chætogaster vermicularis.*
Fig. 25. Seta of *Ctenodrilus pardalis.*

N.B.—The figures are enlarged to different scales; the setæ are very highly magnified.

VI. ON THE APPLICATION OF SEWAGE TO THE SOIL.

By nature man is improvident; in the midst of plenty he is wasteful and inconsiderate; and it is perhaps one of the chief blessings of civilization, that it brings with it conditions calculated to reform this defect in his character.

Where food is plentiful, and the surface of the earth thinly populated, men think little of economy in regard to the products of the soil, and rarely reflect upon the necessity of providing either for their own future wants or for those of their posterity. But in those countries where the land is valuable, the population crowded, and where men are dependent for the supply of their wants upon the industry and productions of neighbouring states, their sense of foresight is quickened, and they cease to think of to-day only, and seek to penetrate into and provide for the future.

In our last number we drew attention to a movement which has for its object the provision of improved dwellings for the artisan class in our large towns, and we then expressed the view that legislation on that subject is of far greater importance to the well-being of the community, than any enactment in connection with the enfranchisement of the lower classes;* and now it becomes our duty prominently to direct attention to another national reform which will, we feel confident, be regarded at no very distant period, as equalling if not exceeding in importance either of those to which reference has been made; namely, the utilization of sewage, especially in our large towns.

Our readers little dream how wide and numerous are the ramifications of this question. The successful execution of the scheme will save innumerable lives, will conduce to the comfort, add to the means of support, and cheapen the food of the poorest as well as of the richer classes.

Without such a reform, our cities would soon become (what portions of them are already) centres of pestilence; meat and bread would be enhanced in value even more rapidly than they are at present; waste lands would remain waste lands for ever, and whilst we should neglect, as now, the most useful fertilizing agent that we possess, casting it into the sea as an alternative to prevent its polluting our rivers and destroying the valuable stores of fish which they contain, we should still be obliged to import at an enormous cost similar materials from foreign lands, which are becoming rapidly exhausted by the constant drain upon them. Certain principles are now well established with respect to this great question, and these may be enumerated as follows:—

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* "The Artizans' and Labourers' Dwellings Bill:" Quarterly Journal of Science,' No. xiii., p. 215.

First, in regard to its sanitary aspect. The present system of disposing of the refuse of our large towns by removing it in a dry (or we should rather say, moist) and solid condition is unhealthy and difficult, and with an increasing population it will become more so from year to year.

Great care will be necessary in effecting the change from the "dry" to the "wet" system, for it has been shown beyond a doubt, that the larger the amount of fæcal matter discharged into the sewers, the greater will be the difficulty in preventing the escape of noxious gases; and it was recently shown by an opponent of the new system, that an imperfect construction of the water-closet or of its connection with the sewers, might even lead to the pollution of the drinking-water supplied to families through the suction or passage of gases from one set of pipes to the other.

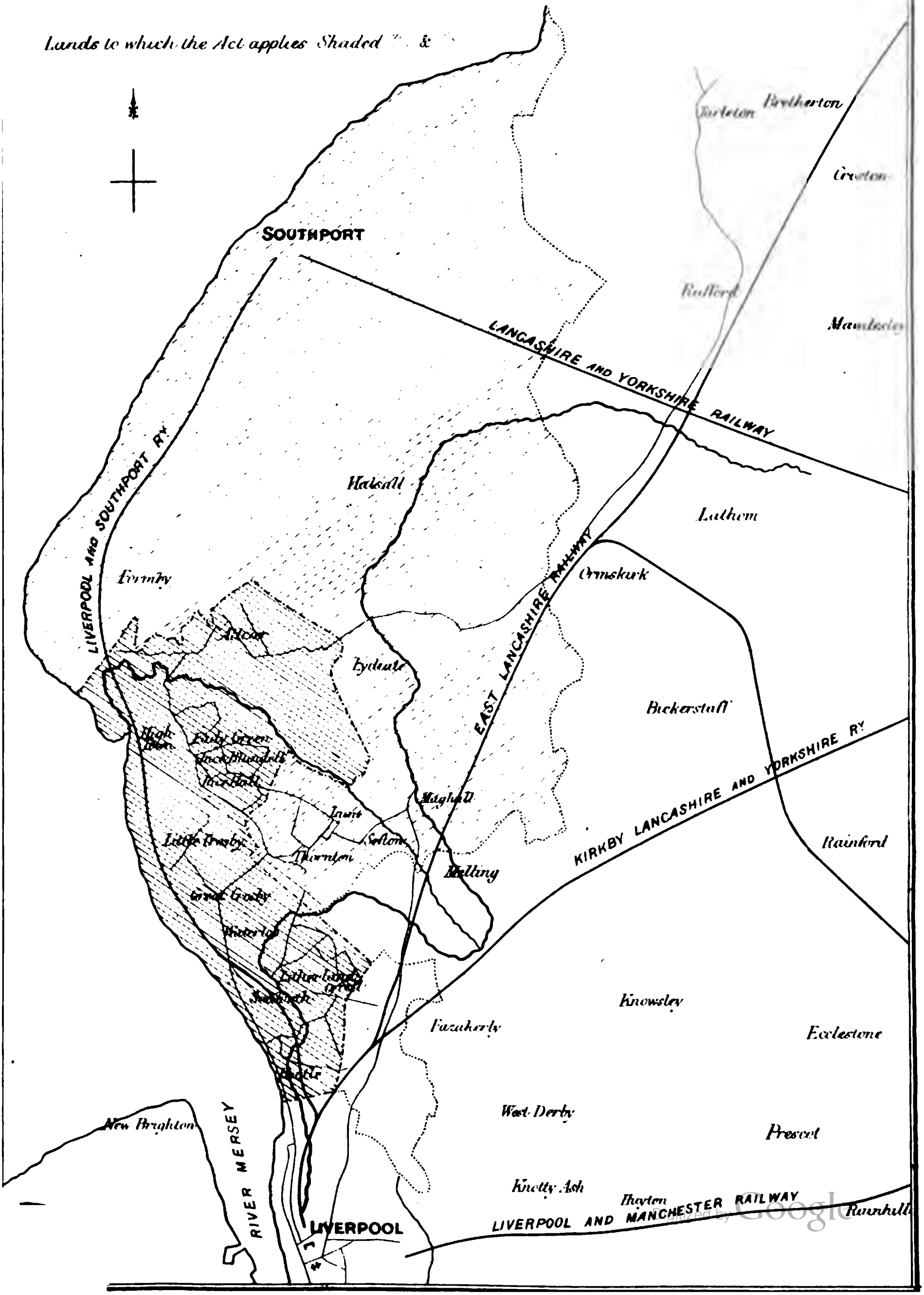
To obviate these difficulties two conditions are necessary; carefully constructed appliances for receiving, carrying away, and storing (when not required for immediate use) the sewage to be utilized, *and a large and constant water-supply.* It would be wasting our own time and that of our readers, to discuss the various minor objections which have been raised against the new system, either by persons interested in some patent, or by those who have hobbies of their own to ride. The fiat has gone forth, that the old system of defecation shall cease; it is troublesome, noisome, degrading (*very* degrading to those labourers who are employed upon it), and barbarous; and it kills its hundreds annually in our large towns.

Just as we have plainly stated the sanitary difficulties as well as the advantages of the new system, so we will now, with equal frankness, detail its commercial and economic benefits and refer likewise to its difficulties. The immediate and undeniable advantages which have already arisen, and will continue to result from the application of sewage to the soil are, the recovery of waste lands and an increase in the area of pasture land, and with it a larger supply of meat, butter, and cheese. To these advantages we see at present no limit even in Great Britain. It is merely a question of steam-power and iron-piping—and there is not a sandy common, foreshore, or plain, which may not be converted into a smiling meadow, yielding repeated crops of succulent grasses for the nourishment of innumerable herds of cattle.

Of this fact there are proofs enough in the operations which have already been carried on for a century on the Craigentinny

LIVERPOOL SEWAGE UTILISATION SCHEME.

SKETCH MAP.



Lands to which the Act applies Shaded &

Meadows below Edinburgh, and which yield 30 or 40 tons of grass per acre; some parts of these meadows have been recently reclaimed from the sea-shore; near Rugby, where Mr. Lawes found the produce of the soil to be in direct proportion to the quantity of sewage applied; at Mr. Marriage's farm of 300 acres near Croydon, which is almost wholly under sewage and Italian rye-grass (this seems to be the plant to which it has been applied with the greatest success), and where 30 or 40 tons of grass per acre were mown in 1864; upon sea-land below Shoeburyness, where rye-grass having been sown, and manured with sewage, at once became fertile and yielded heavy crops; and the case recently reported in a letter from the secretary of the Metropolitan Sewage Company to the 'Times,' which deserves special notice.

The work was done upon "the Lodge Farm" near Barking, and is thus described by Mr. Morgan, the secretary:—

"Notwithstanding the previously severe weather, a crop of Italian rye-grass was cut in the early part of April and weighed 9 tons per acre. The same plot was cut a second time on the 15th May, the crop weighing 12 tons per acre. On May 4 a crop was taken from the adjoining piece of land which weighed 18 tons per acre. There are some 70 acres of land under irrigation, which, it is expected, will cut six times during the year."

Now, it must be quite clear, that with meat, butter, cheese, and milk constantly increasing in value, the enormous additions to our pasture areas which are sure to result from the reclamation of waste lands, cannot fail to be of great public benefit; indeed this new source of supply, coupled with the increasing consumption, by cattle, of artificial food (such as linseed-cake, rape-cake, cotton-cake, and palm-nut meal) will, we hope, in time, arrest the upward tendency in the value of those indispensable human requirements. The obstacles to be contended against by the promoters of this great scheme are few, the chief one being that which accompanies all new undertakings, namely, prejudice. Fortunately, however, the diffusion of knowledge amongst the farming community spreads almost as rapidly as in every other class; and whilst such men as Messrs. Lawes, Gilbert, J. Chalmers Morton, J. F. Bateman, and Mr. Robert Neilson, form the front rank, led on by so enthusiastic, but at the same time so judicious a captain as Lord Robert Montague, there is little fear for the ultimate success of the undertaking.

The most recent development of the scheme (briefly referred to in our number of last January*) is the one represented in the accompanying plan for utilizing the sewage of Liverpool. This gigantic and philanthropic undertaking will fulfil all the conditions named in the early part of this essay. It will relieve the vast and unhealthy town of Liverpool of one of its chief sources of disease; will provide for the conveyance of the right thing to the right place—will reclaim whole tracts of sand, on which nothing now thrives but broom and rushes, into rich and fruitful meadows; and will set an example that is sure to be followed by other large communities.

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* 'Journal of Science,' No. xiii. Agricultural Chronicle.

From the circular which we have received, it would appear that the promoters of the scheme (and it is already a company incorporated by Act of Parliament) intend to proceed cautiously. At first they mean to collect the sewage, which will become richer and richer every year, in consequence of the changes taking place in the system of defecation at Liverpool, and having first raised it by steam power just outside of the town, to convey it through a system of pipes into the townships of Bootle, Linacre, Litherland, Orrell, Great Crosby, Little Crosby, Ince Blundell, and Altcar, comprising an area of between 18,000 and 20,000 acres, to which the sewage may be profitably applied.

"The engineers of the company estimate the cost of delivering 300,000 gallons of sewage daily as far as Little Crosby, and placing it within the reach of the farmers of about 5,000 acres, at about 12,000*l.* If, however, it was deemed advisable to supply the entire area comprised in the above-named townships, the quantity required would be on the average one million gallons per diem, the cost of which would be about 28,000*l.*" "If a branch pipe were carried up towards Maghull, the cost would be increased to 36,000*l.*, and the area would be about 26,000 acres. These would comprise the whole of the engineering expenses, but it will be for the subscribers to the company to determine the extent to which the undertaking should be carried at its commencement.

"In the township of Little Crosby, about 2,000 acres of land belong to Major Blundell, who is favourable to the scheme, and has offered to place at the disposal of the company a considerable area intersected by the Liverpool and Southport Railway, on which sewage may be used in order to show the effects produced by its application. The works are designed so as to supply the farmers in the district with such quantities as they may require."

The chief promoters of the gigantic undertaking are Lord Robert Montague, Mr. Bateman, C.E., Serjeant Wheeler, LL.D., E. K. Muspratt, Esq., the Borough Engineer, the Water Engineer of Liverpool; the corporation aids the scheme by supplying the sewage, appoints two of its members as Directors of the Company, and, we believe, will participate in the profits when they attain a certain sum.

But it is not on account of any anticipated commercial advantages which may accrue that we recommend the public to encourage this great movement (and we refer of course not to one particular scheme, but to the National undertaking). Ever since this Periodical was commenced we have watched it closely, and its development will be found noted from time to time in our Agricultural and Chemical Chronicles. But now it ceases to be an experimental, and becomes a practical National movement, which deserves and will command the sanction and support of every sanitarian, of every agriculturist, and perhaps, before long, of too many needy speculators. Out of evil cometh good, and if the next mania should be for "Utilization of Sewage Company's Shares," and it should even ruin a few here and there, the ultimate result of the periodical attack, should it manifest itself under this aspect, would be beneficial to the great mass of the population.

Let us, however, trust that no such means will be resorted to for pushing the national enterprise; let us rather hope that a growing sense of responsibility on the part of the guardians of health in our large towns, and the anxiety to utilize every foot of land and every blade of grass will contribute to bring about so desirable a change as that now commencing in our sanitary and agricultural arrangements.

It is hardly necessary to add, that the movement will be watched by us in the future, as it has been in the past, with earnest anxiety for its success, and that whenever or wherever any new development may present itself, it will always be hailed with satisfaction and encouraged to the utmost of our limited powers.

VII. THE PROGRESS OF SCIENCE ABROAD.

1. *Sesion Publica, Aniversario vigesimo-septimo del Instituto Médico Valenciano.* Valencia: Imprenta de D. José M. Garin.
2. *Geology and Agriculture.* By E. St. John Fairman, F.G.S., F.R.G.S., &c. Florence: printed by G. Barbèra.
3. *Experimental Investigations connected with the Supply of Water from the Hooghly to Calcutta.* By David Waldie, Esq., F.C.S. From the Journal of the Asiatic Society of Bengal.
4. *Intercolonial Exhibition of* 1866—*Mining and Mineral Statistics.* By R. Brough Smyth, F.G.S. Lond., &c. Melbourne: Blundell & Ford.
5. *The American Naturalist—a Popular Illustrated Magazine of Natural History.* Salem: Essex Institute (Trübner & Co., London).

How apt we all are to confine our observations on every subject to the limited sphere in which we are daily accustomed to move.

The artist rarely troubles himself about the productions of any pencil but his own, or that of his immediate neighbour; seldom does the *littérateur* of one country watch and make himself acquainted with the poetry and drama of neighbouring nations who use a different tongue, unless perchance one or two brilliant gems should have been translated and set in the formal frame of his native jeweller. And so too it is with science. There are busy hands at work in every part of the world gathering up nature's treasures, and thoughtful brains poring over her secrets and attempting to unravel her mysteries; but how little do the men of one land know what those in another are about?

Such of our readers as are accustomed to glance over the list of publications which are forwarded to us for review, must have been surprised from time to time on reading the titles of books and essays which reach us from far distant lands; but all we can do, in the majority of cases, is to acknowledge their receipt, or transfer some novelty from their pages to our Chronicles of Science.

Let us, however, to-day, drink a little deeper of these foreign draughts; let us, for curiosity's sake, glance cursorily over a few of the pamphlets which have just reached us from various parts of the world.

Here we have, first of all, an odd-looking pamphlet, innocent of thread or paste, folded in a remarkable sheet of pink paper for a cover, and printed on rough dark-coloured paper. It is called 'Sesion Pública, Aniversario vigésimo-séptimo del Instituto Médico Valenciano;' then comes a device composed of sundry skulls, stills, books, and a bust, but the engraving of which is so primitive, that we cannot make out whether it is intended for Galen or Æsculapius; and on opening the pamphlet we find it to be the 'Discurso Inaugural pronunciado el dia 31 de Marzo' de 1867, by "D. Norverto de Arcas Benitez," Licentiate of the Faculty of Pharmacy, &c., to the Medical Institute of Valencia. It runs on to nearly ninety pages, treats of almost everything material and immaterial, and whilst its orthodoxy is undoubted, it does not convey anything either new or interesting; in fact, it is essentially Spanish in its character, and, as will be seen from the following statements, permits no biological heresy:—

"1ª. Que el instinto y la inteligencia son espicificamente diferentes.

"2ª. Que por el instinto, el animal se mueve sin conocimiento de causa."* "Que no hay voluntad ni facultades sino en el hombre, como llevo probado, y por lo tanto almo."†

He believes instinct and intelligence to be specifically different; and as to instinct, the animal moves without consciousness; he believes that he has proved that man alone has a will, and proceeds then to show that his soul is immaterial. What say you to that, Shade of Lamarck? and you, oh! Huxley? believer in the imperceptible transition from "blind force to conscious intellect and will!" Read Don (or Doctor, we don't know which) Norverto de Arcas Benitez, and forsake the errors of your ways. We confess that *we* are not much flattered by the very small influence that the 'Quarterly Journal of Science' seems to have exercised on the blue blood of the Valentian savant.

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* P. 59.

† P. 62.

From Valencia to Pisa is no great step; and thence we receive, "with the author's compliments," another little pink pamphlet (this time beautifully printed in English, by G. Barbera, Florence), on "Geology and Agriculture," by E. St. John Fairman, F.G.S., F.R.G.S., &c., whose object in publishing his essay appears to be to induce the Italian Government "to help by every means in its power the people to supply the expenses necessary for carrying on the business of the country."* "Agriculture," he says, "is more attended to in Piedmont than in any other part of Italy; but although Sardinia abounds in mountains, mining is little practised, and the mineral wealth of the country, notwithstanding that it is believed to be great, has never been ascertained. In those parts of Italy where the principal occupation of the people is agriculture, it is allowed on all hands that it is not skilfully conducted."† "The Government, aided by men of science, should give their attention to this."

We must now wing our flight to Australia, but on the way let us take a glance at what is doing in India.

David Waldie, Esq., F.C.S., &c., sends us a paper reprinted from the 'Journal of the Asiatic Society' of Bengal, describing his "Experimental Investigations connected with the Supply of Water from the Hooghly to Calcutta."

"The subject has been under the consideration of the municipal authorities of Calcutta, who, as is well known, have organized a scheme for the supply of the town from the River Hooghly, for the carrying out of which arrangements are now in progress;"‡ and Mr. Waldie has arrived at the conclusion that "as regards its organic constituents, the Hooghly water taken near Calcutta is at least as pure as any of the waters supplied to London;" "during the hot season it is mixed with sea-water under the influence of the tides, and thereby rendered brackish; this can be avoided by taking the supply of water from further up the river."§ Well, we suppose in the matter of beverages the good people of Calcutta cannot afford to be over particular; but to us the testimony in favour of the Hooghly water seems to be at least questionable.

The 'Geological Survey of India' send us some more of their magnificent publications, but those we must leave to our Chronicler, and continuing our flight, we will settle down for a moment or two at—

Melbourne, whence Mr. R. Brough Smyth, F.G.S., sends us some mining statistics of the Colony of Victoria. The progress of mining in the Colony is indicated in the following extract, and the pamphlet contains an exhaustive description of what is doing in the various mining districts:—

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* P. 5. † P. 6. ‡ P. 1. § Pp. 32, 33.

"In the prefatory Essay on Mining in the Colony of Victoria, which was published with the Catalogue of the Victorian Exhibition in 1861, it was stated that the labours of the miners were confined almost exclusively to the working of, and the extraction of gold from, the auriferous rocks. It was observed that the extraordinary richness of the goldfields, absorbing nearly all the available labour in the country, had to some extent prevented the exploration of the deposits of tin, antimony, iron ore, and coal; and a hope was expressed that in a short time other minerals and metals as well as gold would attract the attention of the capitalist, and that new fields would be explored and fresh sources of industry opened up to the intelligent miner, which would afford employment to a great number of persons. This hope has not been disappointed. Whilst the yield of gold per annum has not fallen off, if we make proper allowance for the reduction in the number of miners, other minerals have been eagerly sought for, and large areas of country have been prospected, and in some parts thoroughly explored.

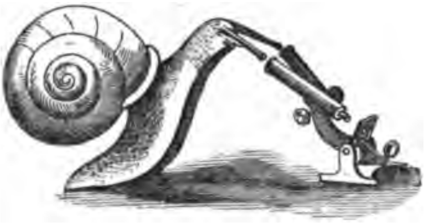
"From St. Arnaud we have obtained silver; from Beechworth and the heads of the Latrobe, fresh supplies of tin; from the River Thompson, in Gipps Land, copper; from Heathcote, large quantities of antimony; from Cape Paterson, coal; from Lal Lal, near Ballarat, lignite; from Omeo, bismuth; from Yackandandah, molybdenite; from Pleasant Creek, the Upper Yarra, and other localities, manganese; from Bulla and Dunolly, clays suitable for the manufacture of the finer kinds of porcelain; from Castlemaine, magnesite; from Maldon, Castlemaine, and Meredith, roofing slates; and from Beechworth, diamonds.

"If all these are not fully represented in the tables, it is not less certain that they occur; and that in due time they will add greatly to the wealth of the country. Gold mining, however, continues to be profitable; and it is not probable that experienced miners will forsake the search for gold, in order to engage in other mining operations which do not offer sure prospects of success, so long as rich quartz reefs and auriferous alluvions lie neglected."

Commending the industry of Mr. Smyth, we once more flap our wings, and sailing through the sky for many a weary day, we alight at length at the door of the 'Essex Institute,' Salem, Mass. The directors must not be offended with us for enlightening our readers as to where Salem is, inasmuch as they set us the example, by informing the readers of their new and beautiful journal, 'The American Naturalist,' that it may be obtained from Messrs. Trübner & Co., London, *England*.

It is a beautiful periodical, and as we read its introduction, we have great hopes of its permanent success. It ends thus:—

"The editorial responsibility seems great, and nothing but the boundless wealth of nature spread out before us, the untiring good will of our scientific friends in contributing to our pages, and the promise of the kindly appreciation of the public, can be an excuse for our appearance, and for any apparent presumption in our bearing."



Whether or not the little cut is meant to represent the "appearance" of the Editor, we are at a loss to explain; but we do hope that it is not intended to illustrate the mode of progression of the scientific world in America, or we should have to recommend our friends to exchange with the 'Instituto Medico Valenciano,' rather than with us. But as we have said, it is a beautiful periodical. The first two parts contain some valuable and well-illustrated papers. Amongst these we commend to the general reader (in No. 1) Mr. W. T. Brigham's visit to the volcano of Kilauea, Hawaiian Islands, in 1864–65:—

"Boston could easily be accommodated within this crater, and Vesuvius would not much more than fill it."* "As we were sitting on the brink, a shrill shriek broke through the night air. We could see the black walls of the crater all around us, and between us and the pathway leading out, a line of watchfires, and I was quite as much impressed as my natives with the direful stories they had been telling me. The shriek was repeated, and it was evidently the utterance of a human being in great agony. Lighting the lantern we had brought for any emergency, we went slowly towards the place, until the shriek was uttered at our very feet. We hastily examined the cracks and called, but there was no answer, and all was still. We looked everywhere, finding no one, and turned to go back, thinking some poor kanaka, venturing down in the dark, had fallen into some crack, and at last died.

"We had gone but a few rods when the shriek was repeated. The natives clung to me in mortal terror, but I insisted on going back, and placing the lantern on a rock, we sat down to await developments; it seemed as though the question, 'Are there any spirits present?' was quite superfluous. We sat more than five minutes in silence, and I could feel the poor fellows tremble as they sat close up to me. Then the shriek was repeated, but we saw the spirit that made it—a jet of steam—and my boys were encouraged."*

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* P. 17.

The crater may be correctly depicted in the plate, but it is not well executed.

On technical subjects we have beautifully illustrated papers on "The Land Snails of New England," by E. S. Morse (Nos. 1 & 2); "The Moss Animals or Polyzoa," by A. Hyatt (No. 2); "The American Silkworm," by L. Trouvelet; also, "The Fossil Reptiles of New Jersey," by Prof. E. D. Cope (No. 1); "Winter Notes of an Ornithologist," by J. A. Allen (No. 1); and "The Fertilization of Flowering Plants."

The leading men of science in America are amongst the contributors to the 'American Naturalist,' and it is in every way worthy of the great nation which it is intended to interest and instruct.

And now we must close this brief notice of a few of the pamphlets and periodicals which find their way to us from every quarter of the globe. The motley collection may have induced us to smile a little over their appearance, but not the less do we value their contents. They betoken a growing spirit of research all over the world; and the very delivery of an Inaugural Address in Valencia, and the publication of a charming popular periodical on Natural History in Salem, Mass., are evidences of the spread of scientific knowledge; of an increasing taste for the study of nature and her laws; and we should feel grateful to Providence, that, through this interchange of thoughts between nation and nation, between mind and mind, we are permitted to obtain a glimpse of an ever unfolding, ever spreading Wisdom, destined one day to illuminate the whole world.

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* P. 22.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

The Cattle Plague is still one of the leading agricultural topics. Its reappearance in the London cowhouses within the past few weeks, after so long an interval, has startled us all; and Agricultural Societies, believing that it is the result of an imported poison, are urging upon Government the need of altogether forbidding the landing of live cattle from the continent, or at least of killing all fat stock at the port of debarkation, allowing milch cattle and other stock in "store" condition to leave only after a sufficiently long quarantine. During the last weeks of May the disease, which had since January altogether left the metropolis, reappeared in many cowhouses in the east and north of London; and in several cases large herds have been swept away; the virulence of the attack being just as great as ever. No fewer than sixty cows in one herd of ninety-five were taken in three days from the first detection of a symptom, and the whole were then slaughtered; and the same fate has overtaken several other stocks. The whole of the cattle grazing on Wormwood Scrubs, for example, have been thus disposed of: and it is to be hoped that the severity of the measures which have been adopted may hinder the further extension of the malady. No attempt at cure has hitherto succeeded. Mr. H. Dixon, who has as large and particular acquaintance with English herds as any man, relates in the current number of the English Agricultural Society's journal the few examples known to him of any attempt to deal with the disease. His evidence amounts to little more than that isolation has saved many a herd that was in danger, and that remedies have done hardly anything whatever. Thus, Mr. Davies, of Cheshire, had saved his herd for some months by using chlorine gas constantly in the houses, and hyposulphite of soda in the water given to the cattle; sawdust, too, was used as litter, being more cleanly than straw; but whether the safety of the stock was due to mere isolation or to this disinfection of their houses and this medication of their food cannot be certainly declared. It was not, however, until they had been turned out to the pasture field that they were attacked, and then many of them died. An iodine ointment rubbed on the chest and acting as a counter-irritant, served in two or three cases to give relief when applied early enough; but in only nine cases out of thirty-six did the patient recover. Mr. Aylmer, of Norfolk, tried chloroform: of ninety head, five died before treatment, six were not attacked, and no fewer than forty-one recovered. Full-grown beasts had an ounce of chloroform administered to them each time, calves a quarter of an ounce, and others in proportion to their age. A saturated handkerchief was simply put in a bag, which was hung close under the nostrils and tied by a string behind the poll. Five to seven minutes was generally enough to produce insensibility, and the cattle were kept under its influence for periods of from half-an-hour to two hours. Seven or eight doses generally effected a cure; and they seem to have been administered twice a day. The immediate effect was to sweeten the breath of the animal, the inflammation and fever were reduced, and unless these returned within the day, the case was hopeful. The result of all was that in July, the disease having appeared in April, "Mr. Aylmer found himself with a clean bill of health and with upwards of 50 per cent. of those which had been treated alive and well in their stalls." Notwithstanding, however, the few examples of treatment which seem, like this one, to have afforded some encouragement, it is still almost universally admitted that our only preventive is to be found in isolation, and our only hope of safety in immediate slaughter.

The journal of the English Agricultural Society contains in its current number a large mass of very valuable information on the subject of steam cultivation. It has been long admitted that a tool drawn across the land and stirring the soil or ploughing it to its full depth, without trampling it and poaching it as horses do when they are the power employed, must be greatly improved in its efficiency as a tillage implement. Experience has perfectly established this wherever the thing has been put to the test on clay land; and many a clay-land farm which could not formerly be cultivated except during short intervals of suitable weather, and then only by a staff of horses which must be kept all through the year for the purpose, has since been a standing advertisment of the superiority of that cultivation by steam power, which could be thus rapidly accomplished during the short intervals when alone clay land ought to be touched, and which at the same time involved comparatively little expense when the tools employed lay idle. It was, however, still generally feared that the cost of steam cultivation was excessive, and either beyond the means of ordinary English farmers or so much in excess of the ordinary experience of horse tillage as to be dearly bought. The large number of instances collected by the Society's commissioners has now sufficiently cleared up whatever was debatable on the subject. They were instructed to investigate not only the depth and character of steam tillage and the improvements it effected in soil and subsoil, but also the detail of the expenditure incurred—the annual expenses connected with it in tear and wear and breakages, and all the other drawbacks to the system. And the conclusion arrived at is for the most part extremely encouraging and will no doubt promote the adoption of all the rival plans of carrying out steam cultivation under the various circumstances appropriate to each. On light soil as well as heavy, the advantage of prompter, cheaper, and more thorough work done by steam power has been perfectly demonstrated.

Since the publication of the report the subject has received prolonged discussion at an unusually full meeting of the Agricultural Society; and it was declared that the advantage of steam cultivation amounted on average soils to at least eight bushels per acre in the produce of the grain crops—that arable culture is by means of it annually becoming both cheaper and better—that the drainage of clay soils is facilitated—that while the direct system of traction adopted by Messrs. Fowler and Co. is the best for large fields and large farms, yet the cheaper round-about-system with a stationed engine and windlass is perfectly satisfactory — that even when coals cost 20*s.* a ton, the power obtained from 6*d.* worth of them is equal to the day's labour of a horse—and that the system wherever it is adopted is improving all the classes interested in agriculture, and is thus establishing on a more satisfactory basis the relations amongst landlord, tenant, and labourer.

The revelations made in a recent Blue Book, of the abuses to which the gang system of employing children in the field has given rise, have excited an interest during the past quarter. In recently enclosed districts, the cottage accommodation is especially deficient. Labourers live in widely separated villages, and the labour of boys and girls in the fields being needed on arable land, they have to walk many miles to and from their work, and, being employed at particular seasons on different farms from their parents, and thus collected in bodies under gang-masters, they are liable to all the risks which association with the vicious among themselves and subjection to an unfit foreman sometimes entail upon them. So much feeling has been excited on the subject, that it is probable some legislation may ensue, limiting the age at which girls and boys shall be employed in this way, as well as the distance from their home beyond which they shall not be allowed to work. The condition of the agricultural labourers which has thus been forced upon our attention by a Royal Commission, is also being urged on public notice by themselves. At Gawcott, in Buckinghamshire, there has been a strike amongst them for higher wages, apparently a perfectly spontaneous act, which has, we believe, resulted in the men out of work being gradually drafted off to other districts at better paid employment; and at Halberton, in Devonshire, the same process has been going on, organized and carried out by the clergyman of the parish, to the great annoyance of the employers.

Though, however, in these two cases, the process has obtruded itself on public attention, it must not be supposed that it is only here that it has been in operation. Almost everywhere the gradual rise of wages in agricultural districts is in progress. Young men refuse employment at the current rate, and go elsewhere for work, and employers are forced to pay a larger sum to their successors. In this way, we may hope that the improved condition of the labouring class will gradually extend, and better cottages and greater comforts will be offered to retain the hands that farmers need. In some few instances, attempts have been made to introduce the co-operative system into agriculture. Labourers have been offered a share in the profits of the business; the capital of the employer receiving a fixed annual sum as interest, the labour of the workman receiving a fixed weekly sum as wages, and the surplus, if any, being divided according to a proportion mutually agreed upon between the two. This system is less likely to gain ground in farming (where so many risks are run, and where the surplus may be sometimes large and sometimes less than nothing) than it is in trade or manufacture, where the risks being less, the returns are much more uniform. Any attempt, however, to attach to one another the various classes interested in agriculture is praiseworthy, whether it be organized in this way or, better still, be the fruit of personal relationship and friendship between the employers and their workmen, and their families one by one.

The subject of emigration, hitherto discussed chiefly in connection with an over-population of the labouring class, has during the past quarter been the subject of a lecture before the London Farmers' Club, in connection rather with our surplus numbers in the class of agricultural employers. And the Rev. G. Smythies has thus pointed out to farmers and their families the opening that exists in the United States, in Canada, at the Cape, in Australia, and in the countries adjoining the River Plate—the opportunities for a prosperous agricultural career, where a smaller capital with the necessary industry and skill will suffice to produce a better income than can be obtained from farming here. A work by Mr. Latham, for many years resident near Buenos Ayres, in which the agricultural advantages of that neighbourhood have been impartially related, has been lately published by Messrs. Longman, and it is significant of the overflowing numbers in the upper agricultural class, that the whole edition has met with an immediate sale.

Among the agricultural publications of the past quarter, we must not forget the volume by Dr. Sellar and Mr. H. Stephens, of Edinburgh, on "Physiology at the Farm in aid of Rearing and Feeding Live Stock" (Blackwoods), which well deserves to be widely studied by the farmer, as a clear and satisfactory exposition of the Physiology and Chemistry of nutrition, and a description of the methods by which agriculturists may turn the information thus given, to account in practice.

The Proceedings of the Society of Arts must not be forgotten in our Chronicle. At Mr. Harry Chester's suggestion, an energetic Food Committee of that body has been employed in collecting and disseminating information on the importation, marketing, preservation, cookery, &c., of all kinds of meat—on the nature of the milk trade by which London is supplied, and on the supply of milk in country districts—also on the economical possibilities of the flour manufacture. A very useful mass of facts has been thus collected, which must ultimately exert good influence on the various departments of the trade in food. Professor John Wilson, of Edinburgh, has called attention, through this committee, to M. Mouriés' plan of dealing with wheat, by which only the outer cuticle of the grain, containing nothing that is digestible as food, is removed. The bran, which is at present taken from the flour, contains no less than 15 per cent. of useful nitrogenous ingredients, and is itself 15 per cent. of the whole grain. The cuticle which M. Mouriés removes is only 4 per cent. of the wheat, and it is not only worthless as food but, owing to its absorbent nature, it is absolutely mischievous, by increasing the difficulty of storing and keeping the grain. The decorticated grain will pack closer, keep better, and yield a larger quantity of more nutritious flour than the whole wheat dealt with as it is by the ordinary English miller.

Yet another matter connected with the Society of Arts has to be reported. It has offered a handsome prize for the best account of harvest process in this and other countries:—"Whereby cut corn may be protected from rain in the field; whereby standing corn may, in wet seasons, be cut and carried, for drying by artificial process; whereby corn so harvested may be dried by means of ventilation, hot air, or other methods, with suggestions for the storage both in the ear and after thrashing; and whereby corn, sprouted, or otherwise injured, by wet, may be best treated for grinding or feeding purposes." The whole must be supplemented by a statement of the practical results, and of the actual cost of each system described; and authenticated estimates must be given of any process proposed for adoption, based upon existing, possibly incomplete, experiments.

The probability of drying grass artificially, except at an expense which will make the process unprofitable, is not very great; nevertheless, it seems that if the data of the books can be realized in practice, the thing is possible, and, if so, the smaller quantity of water contained in ripe grain, and the greater value of the remainder when the water has been dried off and the crop is ready for storage or for market, should make the artificial process of drying grain crops quite successful. It is probable that 100,000,000 grains of water must be driven off from grass to make two tons of hay, or to dry a fair grain crop off four acres of land. To carry this quantity off in vapour will need 10,000,000 cubic feet of dry air, at an ordinary summer temperature; but if the air were heated artificially to 212°, and the water were thus converted into steam at the boiling point, not more than 400,000 cubic feet would be needed to carry it away. Or, supposing that the air was heated up to nearly 212° and could be removed saturated before it had cooled down below 140° in the process—thus carrying off a full load of water at that temperature, then about 1,000,000 cubic feet would be required to make ready for the rick two tons (say 8*l.* worth) of hay, or five acres (say 50*l.* worth) of a wheat crop. We are told in books that 1 lb. of coal will boil off 6 lbs. of water, and if so, we ought to be able with one ton of coal to heat (sufficiently) enough of air to carry off the water which exists in the quantities of grass and corn respectively which have been named. It is to be hoped that the prize offered by the Society of Arts may elicit the results of some satisfactory experiments in connection with this subject.

Among the principal agricultural facts of the past quarter are the extraordinary prices which have been commanded by pure bred short-horn cattle. Mr. Betts's small herd of "Grand Duchesses"—thirteen cows, bulls, and calves—descended from cows of the late Kirkleavington herd bred by Mr. Bates from "Young Duchess," a cow bought at Charles Colling's sale in 1810, have realized at a sale by auction 5,759*l.* 5*s.*, or 443*l.* a piece. Other families of pure short-horn blood have fetched from 130*l.* to 560*l.* a piece at the sales of Mr. C. L. Betts, near Aylesford, Kent, and of Mr. D. MacIntosh, near Romford, Essex. Sixty-three animals of all ages at the former sale made 180*l.* 19*s.* each, and fifty-seven animals of all ages at the latter sale made 116*l.* a piece; and thus Mr. Strafford the auctioneer, sold on two successive days 120 animals of all ages, for 18,000*l.*, or 150*l.* a piece.

An important lecture by Dr. Voelcker before the English Agricultural Society, on the relations of food and manure, throws light on the economics of an important branch of farm practice. The various food constituents were declared to succeed one another in the order of value according to the following list:—

1. Ready-made fat, *i.e.* oil.
2. Starch, sugar, pectin.
3. Young cellular fibre.
4. Albumen, gluten, casein, &c.
5. Mineral matter.
6. Woody matters, which are of little or no value.

But the money value of purchased food depends not only on the actual nutritiveness of the material, but also on the value of the fertilizing matters which pass through the animal into the manure.

Dr. Voelcker estimates that rape cake yields in the manure 4*l.* worth of ingredients for every ton consumed; cotton cake no less than 5*l.* 6*s.* worth per ton of matter in the excrement; linseed cake 3*l.* 15*s.* per ton; beans and peas about 3*l.*; while other feeding substances possess but little worth as regards their fertilizing value. Rice meal, for example, yields but 1*l.* per ton to the dungheap, and molasses hardly anything at all. It is plain that facts of this kind must for the future materially affect the judgment which will guide the choice of purchased food by the farmer.

We have to report that the English Agricultural Society has at length resolved upon confining within professional limits those educational efforts which its charter binds it to make. Hitherto the small contribution made by it in this direction has gone merely towards the granting of prizes to country boys who pass the best examination in branches of general education before the University examiners. Hereafter whatever it may grant will be devoted to the reward of professional studies alone; and some stimulus may thus be given to the work of professional agricultural education, which it has hitherto almost entirely ignored.

We must not close our record without a word upon the Paris Exhibition, to which we had anticipated devoting a large share of our space. The grand programme put forth by the Commissioners has almost entirely failed so far as agriculture is concerned. The periodical exhibition of live stock and of implements at work, which was part of the original scheme, has not been carried out as intended. The display is confined to a mere show of implements by the agricultural machinists of this and other countries, and there is no particular novelty calling for remark. We can only report that in the agricultural department a very small contribution is made to that wonderful general effect which is now commanding such universal admiration.

2. ARCHÆOLOGY AND ETHNOLOGY.

We have this quarter to notice a most exhaustive treatise on ancient writing, by Professor J. R. Stephens, of Copenhagen, entitled "The Old Northern Runic Monuments of Scandinavia and England." Although published in Denmark it is written in the English language, a fact which seems highly flattering to us as a scientific nation. Runes, according to Professor Stephens, "appear at the close of the Roman period, and were employed by the 'Barbarians' who overturned the Roman and Keltic systems." The Kelts "brought with them their Ogham staves and the Romans their alphabet, so the 'Barbarians' brought with them these their native characters." Runic writing, therefore, belongs to a rather later period than that usually termed Pre-historic—to which we usually confine ourselves; but, as will be seen presently, inscriptions have recently been found on cromlechs, which may have some light thrown on them by a study of Runic lore; therefore we have thought it right to call attention to this masterly publication. Respecting the Oghamic inscriptions, to which we shall have further occasion to refer, Professor Stephens remarks, "First and earliest, in my opinion, are the monuments bearing the Ogham-marks. Some 300 of these pillar-stones have been found in Ireland, which country bears the same relation in this respect to the other Keltic lands as Sweden does to the Northern as to the Runes. The great mass of the Ogham stones is in Ireland, the great mass of the Runic stones is in Sweden." Thus, we suppose, the Irish Kelts were at one time the most civilized people in Europe. As an example of their writing we have reproduced a figure (Plate, Fig. 4) of an Ogham stone from Dunbel, Kilkenny, the characters on which have been interpreted to mean "Sacred stone of Eochaidhe of the Excavations." The student must consult Professor Stephens's work to be able to appreciate its importance and interest, and to learn what light Runic writings throw on doubtful points of history and tradition; but some idea of the difficulties which the author has surmounted may be gained by our stating that he has tabulated and correlated upwards of fifty distinct Runic alphabets.

In the 'Proceedings of the Royal Irish Academy,'* which has been published during the past quarter, are some important archæological papers by Mr. E. A. Conwell. The first is an abstract of his account of an "Examination of the ancient Sepulchral Cairns on the Loughcrew Hills, County of Meath (Part 1)," which gives just sufficient details to excite curiosity and interest. These cairns are thirty in number and vary considerably in form, dimensions, and completeness. Of some, very few stones are left, those missing having been apparently quarried away within a comparatively recent period. Taking the one marked H as being of perhaps the greatest interest, we find that its remains are between five and six feet in height and eighteen yards in diameter. The covering of the interior chambers has disappeared, with the exception of about half a dozen large overlapping flags, which are still to be seen in their places over the western and northern crypts, and give a good example of the mode of roofing. The plan is cruciform, the central chamber being a rude octagon. From the passages and crypts the author collected several hundred portions of human bones and skulls, fourteen separate teeth, and eight portions of jaws with teeth remaining. He also obtained a remarkable collection of bone implements (4,884 pieces); beads of amber, glass, and bronze; with

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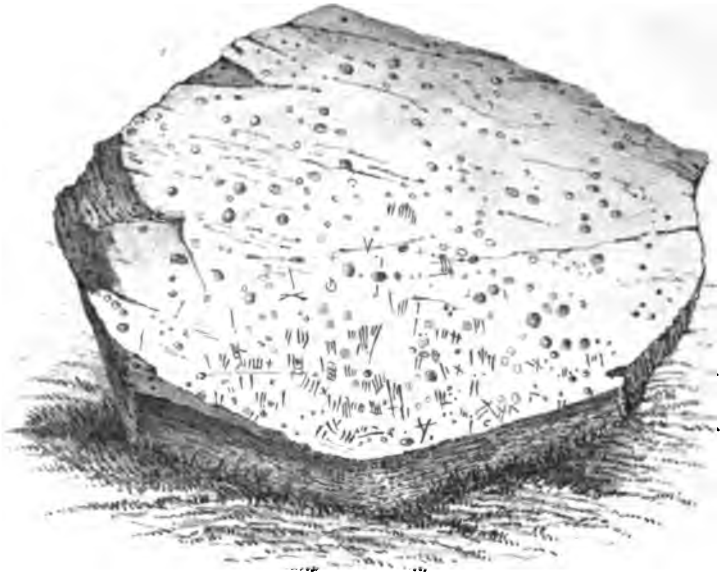
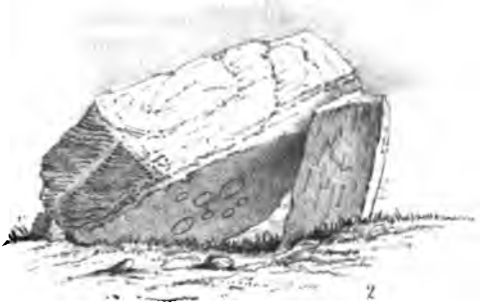
* Vol. ix., part 4.





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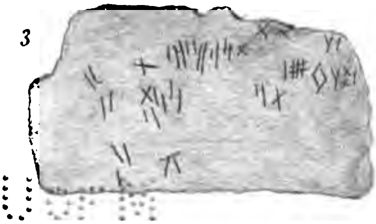

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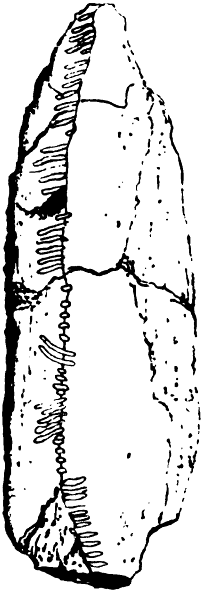

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ANCIENT IRISH INSCRIPTIONS.

rings and a few tools of iron. In this cairn are five inscribed stones. Several of the cairns contain inscribed stones, and the author gives a classified list of the characters on them, to the number of 1,393 separate devices, or many times more than had been previously supposed to exist in Ireland. Mr. Conwell does not indicate the age of these cairns, nor the nature of the inscriptions, except in recording the occurrence, amongst the latter, of "nearly 300 single straight lines, some of which may probably be Oghamic."*

Passing by a paper on an obelisk on Tarra Hill, supposed to be the "Lia Fail," or "Stone of Destiny," on which the Irish kings were formerly crowned, we come to an important memoir by the same author "On an inscribed Cromleac near Rathkenny, Co. Meath." The inscribed stone exhibits on its upper surface a most interesting series of lines, consisting of upwards of ninety separate characters (see Plate, Fig. 1), still showing "the original clean and smooth cutting—for the most part in a triangularly shaped hollowed line—some to the depth of nearly a quarter of an inch." On the under side seven circles are cut (see Plate, Fig. 2), and as many more are visible on the opposite face of an upright stone against which it leans. The sculpturing of the circles is rude, and bears a strong contrast to that of the lines. On the same surface of the slab as the latter are upwards of 300 depressions or cup-shaped hollows, which are probably the result of weathering and not artificial (see Plate, Fig. 1). Mr. Conwell does not attempt to give the meaning of the inscription, nor does he hint at the style of writing to which it may possibly belong. We may remark, however, that in the prevalence of simple lines it has an Oghamic affinity, while a few characters have a somewhat Runic appearance. To show that this is not the only example of such an inscription, Mr. Conwell has reproduced a tracing of one on a cromleac near Macroom, County Cork; and as we have copied this figure also (Plate, Fig. 3), our readers will perceive the striking similarity of the two inscriptions.

The Royal Irish Academy has also published† a valuable memoir by Capt. Meadows Taylor "On Cairns, Cromlechs, Kistvaens, and other Celtic, Druidical, or Scythian monuments in the Dekhan." It would occupy a Chronicle to describe these remains, so we must content ourselves with recording the author's summary of his discoveries. These are, "(1) Cromlechs, or open monuments, with and without circles of stones, containing no remains; (2) Kistvaens, with and without circular perforations in a side-slab, and with and without covering slabs, containing human ashes, bones, and broken pottery; (3) Cairns and barrows, with single, double, and treble circles of rocks and stones, containing cists and skeletons, with traces of human sacrifice, pottery, arms, &c.; others with cinerary urns interred in them without cists; (4) Rock-temples, with circles of stones round them; (5) Lines of rocks placed to mark boundaries for cairns; (6) Square and diagonal platforms of rocks enclosing cairns; (7) The great parallelogram and place of cremation at Shahpoor." These embrace nearly all the known forms of Druidical or Scythian remains, and the author therefore concludes that they establish the identity of the great Aryan nomadic tribes of the east with those of the west. The almost perfect similarity of the monuments of worship and sepulture in the two regions is evidently too remarkable to be doubted. Indeed, Capt. Taylor, in a subsequent paper on "A Group of Ancient Cairns on Twizell Moor, in Northumberland," points out that these agree in very minute points with those he had previously described as occurring in India. These two papers are worthy of careful study by the philologist as well as the antiquary, for if the remarkable similarity between the Cairns and Cromlechs of England and those of India really bear the interpretation suggested by the author, the existence of the people termed Aryan by the philologist is no longer a mere theory, *pour servir*, but is an historical truth.

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* For an example of an Oghamic inscription, see Plate, Fig. 4.

† Trans. Roy. Irish Acad., vol. xxiv., part 5.

In Part IV. of the 'Reliquiæ Aquitanicæ' is a discussion by the late Mr. Christy on the antiquity of the Reindeer-period in Southern France,—a question of considerable difficulty with regard to dates, but comparatively easy if the object be merely "to indicate its place in the series of observed facts in relation to ancient man." Mr. Christy is doubtless correct in stating that it is "of higher antiquity than the Kjökkenmöddings of Denmark and the Lacustrine dwellings of Switzerland, and very certainly than the whole group of so-called Celtic and Cromlech remains." His other conclusion "that, so far, nothing in the investigation of the works of uncivilized or primitive man, either of ancient or modern times, appears to necessitate a change in the old cherished idea of the Unity of the Human Race," will probably be called in question by many. Indeed, it is not by any means an accepted principle that a similarity of design in certain of man's works is any sure indication of unity of origin. Therefore, although it is probable that the conclusion is true, it is neither confirmed nor controverted by the evidence here brought forward.

Amongst the specimens figured in this part are two hollowed pebbles of granite, the use of which is very doubtful, unless they were mortars, and there are difficulties in the way of even this interpretation.

The 'Anthropological Review' for April contains several articles of considerable interest, including the commencement of two of a general character, which will well repay perusal, namely, Dr. Broca on Anthropology, and Prof. Carl Vogt on "The Primitive Period of the Human Species." There is also a paper by Dr.

Robert H. Collyer on "The Fossil Human Jaw from Suffolk," in which the author quotes the opinions of several eminent osteologists as to the age of this famous "Coprolite Jaw." Mr. Busk, who has most carefully examined it, states that "though not of the portentous antiquity it would have claimed, had it been cotemporary of *Elephas meridionalis*, the 'coprolite jaw' fairly claims a considerable age." The beds at Foxhall, near Ipswich, from which the jaw was said to have been obtained, belong to the coprolite-yielding Red Crag, and *are* of the age of *Elephas meridionalis*, so clearly Mr. Busk thinks it is of posterior date. Mr. Collyer, however, observes that "when he [Mr. Busk] says the coprolite jaw is of very great antiquity he admits the whole question."

The 'Journal of the Anthropological Society' contains an interesting paper by Lieut.-Col. Lane Fox, entitled "A Description of certain Piles found near London Wall and Southwark, possibly the remains of Pile Buildings." The bones found with the piles at London Wall belong chiefly to domestic animals, but mixed, according to Mr. Carter Blake, with a cave-species of goat (*Capra pyrenaica*) and with two extinct species of ox, viz. *Bos longifrons* and *Bos trochoceros*. The works of art associated with them were, curiously enough, partly Roman, and partly of a ruder construction, namely, "handles and points of bone," which, in the opinion of Professor Owen and Mr. Blake, "may possibly have been formed with flint;" but Col. Lane Fox has been unable to ascertain that they were found at a lower level than the Roman remains, or that any flint implements have been found in the place. Still, to whatever period this mixture of remains may belong, the occurrence of traces of pile-dwellings in the valley of the Thames is a fact of very high interest.

There is also a paper by the Rev. Dunbar Heath "On the Way in which Large Bodies of Mute Men would acquire Language from Small Bodies of Speaking Men."

Almost simultaneously with the discovery of pile-dwellings in London has appeared the announcement of the finding of flint implements, associated with the remains of living and extinct species of mammals, in Paris. Amongst the mammals are *Elephas primigenius*, *Elephas antiquus*. *Rhinoceros tichorhinus*, *Hippopotamus amphibius*, *Bos primigenius*, *Bos taurus*, *Cervus Canadensis*, *Cervus elaphus*, &c. Further details are given in two papers in the last number of the 'Bulletin de la Société Géologique de France,'* namely, "Recherches archéologiques et paléontologiques faites dans l'intérieur de Paris," by M. Reboux; and "Sur les instruments humains et les ossements d'animaux trouvés par MM. Martin et Reboux dans le terrain quaternaire de Paris," by M. Albert Gaudry.

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* Vol. xxiv., No. 2.

The last volume of the Transactions of the Ethnological Society contains so large a number of papers that we can notice only a selection from them. In Mr. Crawford's paper "On the Physical and Mental Characteristics of the European and Asiatic Races of Man," the author arrives at the conclusion that between these races "there is a broad innate difference, physical, intellectual, and moral; and that such difference has existed from the earliest authentic records and is most probably coeval with the first creation of man." The same author has a paper on the History of Written Language, in which he brings forward his theoretical views on the subject, some of which appear scarcely in unison with facts. He endeavours to show that written characters were used in Asia long before they were in Europe; and he states that in the time of Julius Cæsar our ancestors were "as illiterate as are now the negroes of Ashantee, or as were the cannibals of New Zealand when Cook first described them." His argument appears to be that in Asia every nation has its own written alphabet, and sometimes more than one, except where that of some other nation has superseded the original one, while in Europe the Greek and Roman characters are in universal use. Indeed, he states that "no race from the Euxine to the Atlantic, or from Greece to Scandinavia, has ever invented an alphabet." Does not Mr. Crawford know that the Roman alphabet superseded the Runic in Scandinavia and England, that the Ogham staves of Ireland are still older, and that other phonetic writings have been discovered whose age and meaning are as yet unknown?

Sir John Lubbock and Mr. Frederick Lubbock, in a paper "On the true Assignation of the Bronze Weapons, &c., found in Northern and Western Europe," defend with considerable success the antiquity of the weapons of the Bronze age, in contravention of Mr. Wright's theory that they are of Roman origin.

Mr. Wright has a paper "On the Intercourse of the Romans with Ireland," in which he shows that authentic discoveries of Roman coins have been made in five Irish counties, and all, with one exception, in the province of Ulster. Professor Steenstrup and Sir John Lubbock describe the Flint Implements recently discovered near Pressigny-le-Grande; Mr. Crawford has three papers "On the History and Migration of Cultivated Plants in reference to Ethnology;" and Mr. R. Dunn contributes an article entitled "Archæology and Ethnology: remarks on some of the bearings of Archæology upon certain Ethnological Problems and Researches;" but these and some other papers of interest we have no space to discuss.

A noteworthy paper by Dr. Faudel, "Sur la découverte d'ossements fossiles humains dans le lehm de la vallée du Rhin à Eguisheim, près Colmar (Haut Rhin)," has been published this year in the Bulletin of the Colmar Natural History Society. The human bones consist of a frontal and a right parietal, almost entire, belonging to the same skull; and they were found associated with remains of the Bison, *Elephas primigenius*, &c., in the Lehm or Loess of the valley of the Upper Rhine. From their discovery the author infers that man existed in Alsace prior to those changes which, coming after the deposition of the diluvium, gave to the country its present outline.

An International Congress for Anthropology and Prehistoric Archæology is announced to be held in Paris, under the Presidency of M. Lartêt, from the 17th to the 28th of August inclusive.

EXPLANATION OF THE PLATE.

Fig. 1. Inscribed slab of a cromlech near Rathkenny, Co. Meath; copied from the Proceedings of the Royal Irish Academy, vol. ix., plate 12.

Fig. 2. Side-view of the inscribed cromlech near Rathkenny, Co. Meath, showing the inscribed circles on the under surface of the inclined slab (Fig. 1), copied from the Proceedings of the Royal Irish Academy, vol. ix., plate 11, Fig. 4.

Fig. 3. Tracing of an inscription on a cromlech at Macroom, Co. Cork, copied from the Proceedings of the Royal Irish Academy, vol. ix., plate 11, Fig. 3.

Fig. 4. Ogham Stone from Dunbel, Kilkenny, copied from Professor Stephens's 'Runic Monuments,' part 1, p. 57.

3.—ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

Observation of the meteor-shower of last November, and a careful discussion of the phenomena, have resulted in one of the most interesting discoveries which has for many years been effected by astronomers. In our last Chronicle we pointed out that the want of observations determining the velocity with which the meteors travelled, left us, apparently, no choice but to select the most probable period of revolution, out of several which accounted for the observed recurrence of maximum displays. For reasons there discussed, astronomers selected a period falling short of one year by one-33rd part. The most natural explanation of the well-marked period of 33¼ years—the supposition, namely, that this interval is the true period in which meteors complete a revolution around the sun—was looked on as far less probable. The objections to this view are:—(i) The *à priori* improbability that an orbit of such eccentricity as the supposition implies, should intersect the earth's orbit; (ii) the further improbability that the intersection should fall so near the perihelion of the meteor's orbit as to account for the position of the radiant-point; and (iii) the difficulty of conceiving that an orbit of such extent should be so plentifully bestrewn with meteors as to give a yearly recurrence of showers besides the great displays occurring at intervals of 33¼ years.

Leverrier, however, calculated the orbit on the supposition of a period of 33¼ years. It is easily shown that the orbit has a mean distance exceeding that of Saturn; and that, owing to its eccentricity, its aphelion extends beyond the orbit of Uranus.

But the difficulty lay in deciding between this orbit and that adopted provisionally by Professor Newton, and supported by the strongly-expressed opinion of Sir John Herschel. There was but one phenomenon available for the decision of this question—but the consideration of this phenomenon brought the question immediately into the class of the abstrusest mathematical problems. On examining the dates upon which the shower appeared in former years, it is seen that these dates fall later and later in the year at each successive recurrence. Thus in the year 902 A.D., when the earliest recorded shower took place, it occurred on Oct. 12th O.S., or Oct. 17th N.S., four weeks earlier than the present date of the shower. This corresponds to an annual displacement of the node of the meteor's orbit by 102″·6, with respect to the equinox, or by 52″·4 with respect to the fixed stars. Now it is possible to calculate the secular motion of the node for an orbit of given period, though the problem has peculiar difficulties, either when Professor Newton's assumed period is taken, or when the eccentric orbit corresponding to the period of 33¼ years is considered. Professor Adams has calculated the nodal motion for both cases. In the first case he obtained an annual retrogression of only 21″ instead of 52″·4. In the latter he obtained a retrogression of 28′ in 33¼ years, or about 50″·5 in one year, a result according so closely (considering the circumstances) with observation, as to leave no doubt that 33·25 years is the true period of the meteoric orbit.

A result yet more interesting appears to flow from Adams's researches. When the orbit of the meteors is calculated, it appears that its elements agree in the most remarkable manner with those of a periodic comet discovered in January, 1866. The following table exhibits this agreement:—

	November Meteors.	Comet I., 1866.
Period	33·25 years (assumed)	33·18 years.
Mean distance	10·3402	10·3248
Eccentricity	0·9047	0·9054
Perihelion distance	0·9855	0·9765
Inclination	16° 46′	17° 18′
Longitude of node	51° 28′	51° 26′
Longitude of perihelion	57° 19′	60° 28′
Direction of motion	Retrograde	Retrograde.

Close as the approximation appears, it would be yet closer if we assumed (as we are free to do) that the period of the meteors is 33·18 years instead of 33¼, a professedly rough approximation.

Singularly enough this particular comet is the only one which has been satisfactorily subjected to spectrum-analysis. Mr. Huggins found that the nucleus was gaseous, and that the coma was either composed of (finely divided) matter in a state of incandescence, or shone by reflected light. The comet had no visible tail.

Signor Schiaparelli had before noticed that if we suppose the August meteors to describe a very eccentric orbit (as their great velocity entitles us to do), the elements of their orbit, calculated from the observed position of their radiant point, agree very closely with those of the orbit of Comet II., 1862. The following table exhibits the resemblance between the orbits:—

	August Meteors.	Comet II., 1862.
Perihelion distance	0·9643	0·9626
Inclination	64° 3′	66° 25′
Longitude of perihelion	343° 28′	344° 41′
Longitude of node	138° 16′	137° 27′
Direction of motion	Retrograde	Retrograde.

The period of this comet, which it will be remembered was a large and in other respects remarkable one, has been calculated by Dr. Oppolzer to be about 142 years, and the orbit extends into space far beyond that of Neptune.

Dr. Edmund Weise, of Vienna, has pointed out the coincidence of many other observed meteor-tracks with cometic orbits. We conclude the discussion of this interesting subject with his sketch of the process by which the whole orbit of a comet is conceived to be strewn with meteoric bodies, not following each other in one path, but dispersed many thousands, perhaps many millions, of miles on every side of the central track. If we consider, he says, the circumstances under which a comet approaches the sun, we shall see that individual particles must be repelled to a distance where, "collecting under the original laws of aggregation around new centres of gravity, they will revolve about the sun in orbits closely resembling that of the parent-comet. In the case of periodical comets, these dispersed aggregations will gradually collect along the whole orbit, and if the comet's orbit intersect, or approach very near to the earth's orbit, the phenomenon of periodic showers will be produced at the annual passage of the earth through the point of intersection."

Mr. Stone has detected a small error in Leverrier's determination of the Solar Parallax. The error lies in the numerical work. Leverrier's method is (in theory at least) very beautiful, and is little known. The earth has an orbital motion around the common centre of gravity of the moon and earth; the diameter of this orbit being about 6,000 miles. In Leverrier's method the earth's motion in this small orbit is taken advantage of to determine the sun's distance. The size of this subsidiary orbit being determined from the estimated mass of the moon, and the displacement of the sun due to the earth's excursions in her monthly orbit being determined from a careful examination of a long series of observations, the ratio of the sun's distance to the moon's is determined by a simple calculation. Owing to a mistake in the numerical work, Leverrier took the moon's mass at $\frac{1}{81\cdot38}$th instead of $\frac{1}{81\cdot38}$th of the earth's. The effect of the correction is to reduce the solar parallax from 8″·95 to 8″·91, corresponding to an increase of upwards of 400,000 miles in the sun's estimated distance. The weak point of the method clearly lies in the great variation resulting from a very small change in the estimated value of the moon's mass. On this account the observations made use of are better fitted for the solution of the inverse problem, the determination of the moon's mass from the earth's parallactic inequality; and, indeed, Delambre has already made use of this method for the purpose named.

The corrected estimate of the sun's distance, by Leverrier's mode, agrees with Hansen's determination from the moon's parallactic inequality. Mr. Stone, who had obtained the value 8″·94 for the solar parallax from observations of Mars, has lately deduced the value 8″·85 (with a possible error of 0″·056) from the Greenwich lunar observations made near the epoch of maximum lunar parallactic inequality. It is to be noticed that when Mr. Stone speaks of the last-named inequality as *corresponding* to the earth's parallactic inequality, he must be understood as speaking merely of nominal correspondence, the two inequalities being quite distinct in character.

During the late opposition of Mars, Mr. Huggins made several observations of the planet's spectrum. As in former observations, groups of lines were seen in the blue and indigo, but it was not found possible to measure these so as to determine whether they are solar or due to the planet's atmosphere. Again, also, many marked lines were seen in the red. On February 14, faint lines were seen near D, and were judged by Mr. Huggins to be due to absorption by the planet's atmosphere, as, although similar to lines seen in the solar spectrum when the sun is low, Mars was not low enough for the production of the lines, which were not seen in the moon's spectrum though she was lower than Mars. The spectrum of the darker portions of the disc was less brilliant than that from the lighter part, indicating equality of absorption, and that the colour of the darker parts is nearly, if not quite, neutral.

Mr. Huggins concludes that the ruddy colour of Mars is not due to its atmosphere, but to the materials of the planet's body; and he remarks that the polar regions show no colour, though the light from them traverses a greater depth of atmosphere than that from the central parts of the disc. This evidence seems conclusive; but Mr. Huggins quotes, as additional evidence, the views of Dr. Zöllner respecting (i) peculiarities in the rate at which the brightness of Mars varies with varying phase, and (ii) the greater brightness of the disc near the limb. Zöllner ascribes these peculiarities to the slope of elevations on the surface of Mars. Mr. Huggins accepts this view as probable, adding that "it is important to remark in this connection that the darker portions of the disc gradually disappear, and the coloured portions lose their distinctive ruddy tint as they approach the limb." This circumstance appears to prove, however, that a considerable portion of the light from the limb has been reflected before reaching the planet's surface. If Zöllner's supposed mountain-slopes (whose angle he determines at 76° !) existed, we should find brighter colours as well as brighter light near the limb, unless we supposed all the *mountain-tops* coloured and their *declivities* white.

On every hand we receive confirmation of Dr. Schmidt's discovery of the disappearance of the lunar crater Linné. After a careful discussion of the evidence, Schmidt comes to the conclusion that the change which has actually taken place corresponds—only on a greatly magnified scale—to the changes produced by *mud-volcanoes* on our own earth. He conceives that the whole of the internal part of the crater has been filled up by erupted matter, which has further overflowed, so as to obliterate under gently-sloping declivities the once steep outer walls of this vast crater. The matter within the crater seems to have cooled since Schmidt, Secchi, and other observers have detected a minute depression nearly in the middle of the light spot which now marks the place of the crater. If we remember that the crater was described by Lohrman, Beer and Mädler, and others, as "very large" (nearly six miles across) and "very deep," we must recognize the fact that lunar volcanic activity is far from being extinguished.

The eclipse of the sun on March 6th, like most partial eclipses, presented no features deserving of special comment. The occurrence of a severe snow-storm in the upper regions of the air during the progress of the eclipse (accidentally discovered by Mr. Browning while changing the focus of his telescope), is so far noteworthy, as it confirms the opinion expressed by many astronomers, that although the total eclipse of August, 1868, occurs at a season when in certain parts of India traversed by the shadow fine weather is ordinarily expected, yet unfavourable changes may take place in the weather during the actual progress of the eclipse, and through causes corresponding temporarily to those which produce the regular breaking up of the fine season. We trust this anticipation will not be verified, and that astronomers will successfully avail themselves of one of the most favourable opportunities that could ever be afforded of determining the real nature of the red protuberances, and other phenomena visible in a total eclipse.

We have to note an error in our last Chronicle. The determination of the epoch (850,000 years ago) at which the earth's orbit attained the greatest eccentricity it has had during the past million years is due to the labours of Mr. Croll, who has calculated a table exhibiting the eccentricity, position of perihelion, &c., of the earth's orbit during the above-named interval.

We remind our readers that on the 21st of August, Jupiter will be without visible satellites from 10h. 4m. P.M. to 11h. 49m. P.M. The hours of disappearance and re-appearance of the several satellites were given in our last.

On August 9th, 10th, and 11th, the St. Lawrence meteor-shower may be looked for. Unlike the November star-shower, the August shooting-stars appear almost as frequently *before* as *after* midnight, the radiant-point being above the horizon throughout the night.

On April 3rd, M. Tempel detected a telescopic comet.

PROCEEDINGS OF THE ASTRONOMICAL SOCIETY.

Mr. Tennant has computed the path of the moon's shadow, August, 1868, across the peninsula of India. The central line passes from near Viziadroog, on the western coast, to near Masulipatam on the eastern, the duration of total obscuration being 5m. 12s. at the first place, and 5m. 45s. at the second.

Mr. Brothers succeeded in taking twenty photographs of the sun during the eclipse of March 6th. Mr. Browning's observation of the eclipse is noteworthy on account of the application of a novel method of viewing the sun. A disc of glass having plane and parallel sides was inserted in the open end of a reflecting telescope. The outer side of the disc was coated with a thin film of pure silver, by Liebig's process. This delicate metallic film reflected nearly the whole of the heat, and the greater portion of the light of the sun's rays, its transparency being sufficient, however, to enable enough light to pass through it into the telescope to render very small markings on the sun's surface plainly discernible.

Mr. Stone discusses the possibility of a change in the position of the earth's axis, owing to "frictional action connected with the phenomena of the tides." After a careful examination of two hypotheses, between which the truth in all probability lies, he arrives at the conclusion that the frictional action of the tides "is not available as an explanation of those secular changes of climate which geologists have shown to have taken place on our earth."

Mr. Joynson presents the results of observations of the planet Mars during the late opposition. He considers that there is a permanent dark band extending all round the planet, with only one narrow break in it. But this description is far from presenting the real complexity of the arrangement of continents and oceans on the southern hemisphere, with which Mr. Phillips's chart and Mr. Dawes's admirable (and consistent) views have familiarized us.

We have an account of a meteor-shower seen at "noon, under a cloudless sky," in Australia, October 25, 1866. One part of the description is not intelligible; we are told that "during (? after) the whole display the sky was filled with a phosphorescence so strong that it gave considerable light to the earth. A river at some distance, which in the clearest moonless nights is invisible from here, glistened quite brightly, even when scarce a star was to be seen through the clouds,"—the hour being noon, and the sky cloudless!

Mr. Masters sends an account of the November meteor-shower as seen at Kishnagur, Bengal. He determined for the radiant-point a position very near that assigned by observers in England. The apex of the Zodiacal light appeared to be some degrees south of the radiant-point.

M. Hoek, in a letter to Mr. De la Rue, discusses the question of solar spots. Taking the mass of a planet and the inverse cube of its distance as the measure of the planet's influence in raising waves of disturbance on the sun, he assigns to Mercury, Venus, the Earth, Mars, Jupiter, and Saturn, effects proportional to the numbers 12, 24, 10, 0, 23, and 7, respectively. This estimate is undoubtedly more correct than that referred to in our last Chronicle.

Sir John Herschel has presented to the Royal Astronomical Society a series of MS. charts, containing the estimated magnitudes of nearly all the stars visible to the naked eye in both hemispheres. The labours of Professor Argelander in the same direction, having been given to the world while Herschel's work was in progress, he was induced to relinquish a task of great labour, and henceforth only of secondary interest. But a large amount of labour having been bestowed on the subject, Sir John considered, and all interested in stellar observation must agree with him, that it would be a pity that the charts should not be preserved.

Mr. Stone has investigated the question of the sun's motion in space by a new and very simple method, founded, however, on views already arrived at on this question. He arrives at the conclusion that there is decisive evidence of the sun's motion, but that the effects of parallactic displacement arising from this motion are on the average much smaller than the independent proper motions of the stars.

Mr. Chambers has compiled a catalogue of temporary stars. Many of the objects included in this catalogue were doubtless comets.

We commend Mr. Dawes's paper on the micrometrical measurements of double stars to the careful study of the telescopic observer.

Mr. Cleveland Abbe presents a paper on the distribution of Nebulæ. He finds evidence that clusters and planetary nebulæ belong to the Via Lactea, while other nebulæ form independent systems, of which the Nubeculæ are members. It does not appear to have occurred to those who have dealt with this subject, that the marked absence of nebulæ from the zone of the Via Lactea affords as striking evidence of a close relation between the nebular and sidereal systems, as the contrary phenomenon of *aggregation* along that zone would have afforded.

Mr. Kincaid describes an instrument called a *metrochrome*, for detecting changes of star-colours. Such changes have only been certainly noted, as yet, in the case of Sirius and 95 Herculis. They are very difficult to detect, since observers differ greatly in their estimate of colour. Spectrum analysis requires "superlatively fine" weather, and is also for other reasons surrounded by great and numerous difficulties, which render its application almost impracticable. The great difficulty, so far as other methods are concerned, lies in the selection of a standard of reference. A painted scale, like that given by Admiral Smyth, is objectionable on account of the opacity of its colour; and is further not sufficiently reproducible. Precious stones are beyond the reach of most observers. It has been suggested by Mr. Proctor that the illumination of a minute white disc in the focus of a positive eye-piece, "through differently coloured glasses placed on a rotating disc," is a method which might be employed with advantage. Mr. Kincaid prefers the use of chemical solutions (a method suggested by Mr. Huggins). He uses a rotating drum with six equidistant openings, three of which are so constructed as to admit flat-sided stoppered bottles containing differently coloured chemical solutions; the other three openings transmit the normal light of the lantern. By wholly or partially covering one or more of the former openings, and by communicating a rapid rotation to the drum, it will be possible to reproduce the light of a particular star. This light thrown into the telescope produces the image of an artificial star.

4. BOTANY, VEGETABLE MORPHOLOGY, AND PHYSIOLGY.

AMERICA.—*Origin of the Canadian Flora.*—Dr. Dawson, of Montreal, has published in the 'Canadian Naturalist' a list of some species of plants he has found in the well-known deposit of Leda-clay at Green's Creek, on the Ottaway, from which he has been able to arrive at a satisfactory estimate of the climate prevailing there at the time of their deposit. Among the species are, *Drosera* *rotundifolia*, L., *Potentilla canadensis*, L., *Populus balsamifera*, L., *Potamogeton pusillus*, L., and *Perfoliatus*, L., and others. From the list, it appears that the plants found are a selection of the most hardy species from the present Canadian flora. Dr. Dawson shows that this cannot have been an accidental selection, nor due to the river bringing refuse from more northern latitudes. Hence we must infer refrigeration, and that there *was* such an amount of refrigeration as these plants seem to indicate is borne out further by what would necessarily occur were the land again submerged to the extent that it was at the time of the deposition of the *Leda*-clay. A climate like that of the Labrador coast would be the result.

AUSTRALIA.—*Culture of Fruit Trees.*—Dr. George Bennett publishes an interesting account, in the 'Journal of Botany' for April, of the extensive orangeries and other fruit-gardens near Paramatta, New South Wales. Oranges, Lemons, Apples, Pears, Loquats, Apricots, Peaches, and superior varieties of Grapes are grown in great profusion, both for export and home consumption, and exhibit a most striking instance of the success attendant on well-directed efforts at acclimatization. The orange, apple, and lemon trees of Mr. Pye, of Paramatta, are grown in a soil consisting of a very poor sandy loam, from which crop out all over the region, large sandstone rocks, the trees being planted around and between them. In the Azores many of the orange gardens are formed in places where there is often not a greater depth of soil than 18 or 20 inches above the shattered volcanic ash. In New South Wales the orange trees frequently give three crops in the year, the fruit of each crop differing considerably in form and size, but all being of excellent flavour. Oranges frequently remain on the tree over fifteen months, and when gathered are in excellent condition. The largest trees grown in this orangery were over 35 feet in height and about the same diameter, such a size being very remarkable. In an orangery in which there were about 70 trees to the acre, Dr. Bennett states that ten on the average yielded 550 dozen oranges in one year. The wholesale price at which they are sold is from 7*d.* to 8*d.* a dozen, anything over 2*d.* per dozen remunerating the grower. The greater number are exported to Tasmania, Melbourne, and New Zealand. Dr. Bennett also expresses his belief that the thin-skinned pipless oranges which are sometimes called the "St. Michael's oranges," are only the result of age and careful cultivation of the tree which produces them; it appears that they cannot be got from seedlings or young cuttings. Wax models of some of the fruit and photographs of the trees in these Australian orangeries have been sent to the Paris Exhibition, where it is believed they will compare very favourably with those of the Northern Hemisphere.

Edible and Poisonous Plants of the order Apocynaceæ.—Dr.

Bennett describes an edible plant, *Alstonia edulis*, found in New Caledonia—the natural order to which the Tanghina Poison-tree of Madagascar belongs—as also the Strychnos, or Nux vomica, and the Oleander; the same order, on the other hand, includes the useful Hya Hya, or Milk-tree, of Demerara (*Tabernæmontana*), the Cream-fruit-tree of Sierra Leone (*Roupellia*), and many others. The *Alstonia edulis* is a climbing plant, the fruit-pods of which are much used in New Caledonia both by natives and Europeans as an esculent vegetable. Another species of *Alstonia*, which is of considerable use dietetically, is the *A. constricta*. It is the Bitter Bark-tree of the colonists, and was supposed at one time to have the properties of Quinine. It really, however, more closely resembles Quassia, and is used as a tonic and for preparing "bitters." Dr. Bennett directs attention to the desirability of cultivating both these plants with a view to their economic applications. Mr. J. F. Wilcox has sent samples of the bark, wood, and decoction of *Alstonia constricta* to the Paris Exhibition.

ENGLAND.—*The Colouring Matters of Plants.*—Though this is hardly the place in which to notice the optical arrangements and working of Mr. Sorby's spectroscope, we may draw attention to some of the results which he has obtained from its use in investigating vegetable colours. At a late meeting of the Royal Society, he described a new method for registering, by means of an interference spectrum, the position and character of the absorption bands obtained in a spectrum by the interposition of a coloured solution between the spectroscope and source of light. He has also made use of the action of sulphite of soda, citric acid, ammonia, and other reagents for separating or modifying these solutions, and has been able to distinguish above 100 distinct colouring matters. The blue of one flower is not the blue of another, nor are all pinks, greens, and yellows of the same component parts. Two or even more separable colouring matters unite in many cases to give a petal its particular tint and often one of these is peculiar to the plant. The most remarkable fact which Mr. Sorby appears to have elicited is that (in all probability) the absorption bands of any single colouring matter occur at equal distances in the spectrum (allowing for dispersion) and hence that we may infer the presence of more than one colouring matter in a solution which gives absorption bands disposed at unequal intervals.

Alleged New British Heath.—Dr. Hance writes in the 'Journal of Botany' for June, that fifteen years since he gathered in South Devon, near Newton Abbot, an *Erica*, which at the time he considered to be *E. mediterranea*, the rare species which grows in Ireland. He now, however, considers the species to be *E. carnea*. This last species is found in Switzerland, Austria, Germany, Italy, Dalmatia, Hungary, and Greece—not in France—whilst *E. medi-*

terranea is met with in Ireland, France, Spain, and Portugal. Whether the species be the Irish or Swiss species, its occurrence in Devonshire is sufficiently remarkable, and should cause careful search in the locality, which Dr. Hance expressly states was quite wild and distant from cultivated land. At the same time very great importance cannot be attached to an identification resting on a solitary specimen gathered so long since, and which may have occurred under circumstances which would explain the matter, but which have now escaped Dr. Hance's recollection.

Double-flowered Ranunculus.—Dr. Maxwell Masters describes a case of double-flower in *Ranunculus ficaria*, the chief interest of which resides in the structure of the carpels and ovules. The carpels were open, and the ovules sprang from the inner surfaces of these carpellary leaves like little buds. The occurrence of two ovules instead of one, in these monstrous fruits, is noteworthy, as also the fact of their originating neither from the margins of the carpellary leaf, nor from a prolonged axis, but from its inner surface. The rarity with which perfect seeds of *Ranunculus ficaria* are formed is to be attributed to the deficiency of pollen in the anthers of these flowers. *Ranunculus auricomus* is frequently sterile, and other plants of the order exhibit a frequent tendency to the unisexual form. *R. bulbosus* has not been recorded with unisexual flowers, but Dr. Masters recently met with a luxuriant specimen of this species in which every flower was fertilized, although there were no perfect stamens in the flowers.

Babington's Manual of Botany.—A sixth edition of this work, so highly valued by every English critical botanist, has just been published. Fifteen plants are admitted into the manual as genuine additions to the British Flora, while five species are recognized as certainly naturalized foreign species. Nearly all of these species have been recorded, and some of them figured, as they were discovered in Dr. Seeman's very excellent journal of Botany. It has been remarked that the comforts and duties of a University chair too often divert its occupier from those labours which were the stepping-stones to the honourable position. This assuredly is not the case with Professor Babington, nor do we know of any chair at either of the English Universities of which so unpleasant an assertion could be maintained with truth.

New Lichens from Cader Idris.—The Reverend W. A. Leighton, in the June number of the 'Annals,' describes a lichenological tour in the neighbourhood of Dolgelly. Cader Idris appears to be a wonderfully productive locality in the way of lichens and mosses, the only disadvantage it presents to the collector being that which befel Mr. Leighton—that of losing the path on the mountain in misty weather while absorbed in the search for specimens. By his excursion Mr. Leighton has added to our British

Flora a score of new lichens, of which six are entirely new to lichenology, and also a new species of *Sphœria*—thus proving that our Welsh mountains, if thoroughly searched, would yield an abundant harvest of good, rare, and novel lichens, and probably many novelties in other natural orders. Dr. Fraser, who accompanied Mr. Leighton, adds a list of more than fifty species of mosses, which he found near Dolgelly, chiefly on Cader Idris.

Protophyta.—While botanists generally and students of Diatomaceæ especially must feel the loss of so ardent an observer as the late Dr. Greville, it is gratifying to find that others are coming forward in his especial field of research. In the last number of the 'Microscopical Journal,' Dr. Lauder Lindsay describes some new species of Diatomaceæ and Desmidiaceæ from New Zealand, and makes some valuable remarks upon the distribution of the Protophyta, and their representatives in New Zealand. The Rev. Eugene O'Meara, in the same journal, describes eleven new and several rare forms of Diatomaceæ which were dredged on the west coast of Ireland, by Dr. E. Perceval Wright, of Dublin. The gathering is chiefly interesting on account of the number and rarity of the known species and the large percentage of new species.

FRANCE.—*Spontaneous Movements in* Colocasia.—M. Lecoq communicates to the 'Comptes Rendus' a notice of some extraordinary vibrations which he has observed to occur regularly in the leaves of the *Colocasia esculenta.* The movements were sufficiently violent to set small bells ringing which were attached to the plant, and thus indicated to M. Lecoq the time of the phenomenon. The vibrations were from 100 to 120 a minute. The plant was kept in a hothouse, and was quite free from draughts or currents of air, which could produce the agitations observed. M. C. Musset published some observations on this plant some time since; he did not observe the movements of the leaves, but noted that during præfoliation the sap was projected from the leaves to a distance of several centimetres through two orifices, in the form of stomata, situated at the apex of the leaf. Eighty-five drops were projected in the minute. The most probable explanation of the *movements* offered by M. Lecoq is that in his plant, for some reason or other, since he did not observe any projection of sap, the terminal orifices were inactive, and that the projecting force was thus converted into a vibrating force.

GERMANY.—*The Function of Chlorophyll in the Chemistry of Plant Life.*—Dr. Ferdinand Cohn, of Breslau, in a paper "On the *Phycochromaceæ* and *Florideæ*," in the January number of the 'Archiv für Mikroskopische Anatomie,' describes at some length the colouring matters of various low forms of Algæ. He shows that the colouring matter in all—red, blue, green, yellow, or brown—contains Chlorophyll, or a closely-allied body, and maintains that Chlorophyll (or some closely-allied modification thereof) is contained in all growing plants, as the principal actor in the process of assimilation, acting perhaps in a manner analogous to that which the oxygen-carrying constituents of blood exhibit in animals. Dr. Cohn has also recently shown elsewhere that the presence or absence of Chlorophyll in the lowest forms of Plants and Animals has a very important bearing on their direction of motion. They always move towards the light, and if variously coloured light be used, towards the highly refractive actinic rays in preference to the thermal red ones.

Dr. Cohn believes that the decomposition of carbonic acid and the evolution of oxygen through the Chlorophyll, under the influence of light, offer a fair explanation of some of the movements of these minute coloured organisms.

A fragment of chalk coated over one half with a resinous cement and placed in dilute acid is projected with the coated surface foremost, by the evolution of carbonic acid from the exposed extremity. In a similar manner, Dr. Cohn supposes that the chemical action induced by the action of light on the chlorophyll aggregated at one part of such bodies, as the *Oscillariæ* or *Euglenæ* may give rise to those axial rotations which frequently become apparent as longitudinal motion. Dr. Cohn also mentions certain *Oscillariæ*, namely, the genus *Beggiatoa*, which, probably by the decomposition of sulphates, develop free hydrogen-sulphide in the water in which they thrive. Since this group of algæ alone can flourish in hot and strongly saline solutions, he suggests that it is probable that the first organisms which were present in the primordial sea which covered the earth, and was of very high temperature, if we may reason upon the inductions of geologists, were *Oscillariæ* or rather *Chroococcaceæ*.

The Situation of the Alkaloids in the Bark of the Cinchonæ.— Any facts relating to the sources or supply of Quinine must have considerable interest. Some years since M. Wigand tried to demonstrate that the alkaloids of the Cinchonas are developed in the liber. He observed that thin sections of the bark soaked in cochineal became stained more strongly in that layer which is known as liber, than in that part of the bark called parenchyma; and from this he concluded that quinine was more abundantly present in the liber than in the parenchyma, acting as a mordant. M. Carl Müller, having failed to confirm M. Wigand's observations, has adopted a different method of examination. He by a very ingenious process separates the liber and parenchyma, and then analyses the two separately. He finds that the parenchyma contains 9·876 per cent. of quinine, whilst the liber only contains 2·462 per cent. It appears also that the quinine is the more abundant in proportion as the bark is more developed, which would lead one to suppose that the production of quinine is in relation with the formation of the liber. This consideration has naturally led M. Müller to inquire at what period and in what region of the bark the first appearance of the quinine takes place, and he proposes to take up this question as soon as he can procure a sufficient number of living Cinchona-plants.

Fungi-spores.—Professor Karsten has published some observations on the stylospores of *Sphæriæ*. *Sphæriæ* were found in the opened anthers of *Fuschia splendens*, which when placed in water, gave exit to a white tortuous thread, which quickly broke up in the water, into innumerable simple oval vesicles. These vesicles when moistened with dilute solution of iodine acquired, like starch, a beautiful violet colour, and when preserved in glycerine, disappeared in a little time. This is probably the first known example of a starch-reaction in the spores of Fungi, as which (and indeed, as stylospores) the corpuscles noted must be regarded, and although a similar reaction of the spores was observed by Currey in the Lichens, and in the plant named *Amylospora tremelloides* by that botanist, it is nevertheless worthy of notice as certainly a very rare occurrence among these plants.

5. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

In recording recent discoveries and progress in Chemistry, we may in the first place mention two facts which have, however, as much relation to physics as chemistry. The first is a new determination of the density of ozone, by M. Soret. We have already recorded* the conclusion to which M. Soret was led by his former experiments, *viz.* that the density of ozone was one-and-a-half times that of oxygen, or 1·658. This conclusion he has recently confirmed, by determining the rate of diffusion of ozonized oxygen, which was found to correspond exactly with the rate required by Graham's well-known law.

We have in several numbers referred to the invaluable labours of M. Berthelot on the Hydrocarbons, and not long since† to his important paper on the action of heat on these bodies. His more recent experiments have been devoted to the oxidation of hydrocarbons, and have yielded interesting results. Acetylene, C_4H_2, only differs from oxalic acid by wanting eight atoms of oxygen. M. Berthelot finds that these can be added directly; and thus, seeing that he has already formed acetylene by the direct union of its elements, we have oxalic acid built up by the successive combination of its constituent elements. In order to produce oxalic acid in this way, gaseous acetylene is shaken up with a strongly alkaline solution of permanganate of potash, added gradually as long as the solution is decolorized, and taking care to keep the flask cool. When the operation is ended, the solution is filtered from the binoxide of manganese. The oxalic acid will be found in combination with the potash, and may be separated by means known to every chemist. Formic and carbonic acids are produced at the same time as oxalic acid, no doubt, M. Berthelot states, by the splitting up of some nascent oxalic acid.

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* Vol. iii., p. 264.

† Page 78.

Several other hydrocarbons were experimented with in the same way. Ethylene gave the same products as acetylene. Allylene gave malonic, acetic, and carbonic acids. Amylene gave oxalic, and a mixture of several others, probably pyrotartaric, succinic, and malonic acids. Styrolene yielded benzoic and carbonic acids.

M. Berthelot has also succeeded in forming toluol synthetically. The formula of toluol, $C_{14}\,H_8$, indicates the addition of marsh gas to benzol with the elimination of two atoms of hydrogen.

$$\underbrace{C_{14}H_8}_{\text{Toluol.}} \quad = \quad \underbrace{C_2H_4}_{\text{Marsh Gas.}} \quad + \quad \underbrace{C_{12}H_6}_{\text{Benzol.}} \quad - \quad 2\,H.$$

The excessive heat required to effect the direct combination of these bodies was fatal to the existence of toluol, and a product of its condensation, anthracene, was obtained. By bringing them together in the nascent state, however, the desired combination was effected, and toluene formed. This was done by submitting a mixture of acetate and benzoate of soda and lime to distillation. Besides toluol some other hydrocarbons were produced, which M. Berthelot regards as higher homologues of toluol.

An important paper "On new Hydrocarbons obtained synthetically" has been published by Fittig & Bigot. For this we must refer the reader to the original, or the translation indicated below.*

The researches of Mr. P. Griess "On a new Series of Organic Compounds, in which Hydrogen is replaced by Nitrogen," have led him to the discovery of a highly explosive series of salts, one of which he proposes as a substitute for fulminating mercury. This is the chromate or chlorochromate of diazobenzol. According to the French patent, it is prepared in the following way:—One equivalent of hydrochlorate of aniline is mixed with two equivalents of hydrochloric acid, and to these one equivalent of nitrite of soda in strong solution is very gradually added. The mixture is left to itself so long as any nitrogen is disengaged. In this way diazobenzol is produced. To precipitate the salt named above, a concentrated solution of one equivalent of bichromate of potash in one equivalent of hydrochloric acid is added. It is unnecessary to say that the precipitate must be collected and dried with the greatest precaution, since its explosive force is said to surpass that of fulminating mercury.

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* 'Ann. der Chem. u. Pharm.' Bd. cxli., p. 160. 'The Laboratory,' vol. i., p. 121.

While on the subject of explosive compounds we notice Mr. Abel's paper on the "Stability of Gun Cotton," read at the meeting of the Royal Society on April 4.* One objection brought against the use of gun cotton is its liability to spontaneous changes, sometimes resulting in explosion, and in other cases rendering the cotton useless. This, as was stated by Mr. Crookes in an article in our first volume,† is simply the result of imperfect manufacture; an opinion which the experiments of Mr. Abel confirm. Tri-nitro-cellulose, or perfect gun cotton, is not liable to any spontaneous change; "but the best manufactured article may contain some organic nitrogenized impurities of comparatively unstable properties, which have been formed by the action of nitric acid upon foreign matters retained by the cotton fibre, and which are not completely removed by the process of purification"—that is boiling the raw cotton in a solution of caustic alkali. It is these impurities—not usually amounting to more than two per cent.—which are prone to change when gun cotton is stored in the dry state.

The first result of the change is the production of a little free acid, and if the change be allowed to proceed it goes on to the complete destruction of the cellulose products. But the experiments of Mr. Abel show that the change may be arrested at the primary stage, and the stability of the material ensured for ever. This result is obtained at once by uniformly distributing through the cotton a solution of carbonate of soda. One per cent. of carbonate of soda, Mr. Abel has found, will afford to the material the power of resisting any serious change, even when exposed to such temperatures as would cause the decomposition of pure and perfect gun cotton without this protection.

Water perfectly protects gun cotton from alteration. Actual immersion is not necessary; if only damp to the touch it undergoes not the slightest change, and may be closely packed in large quantities without risk. The safety from explosion Mr. Abel courageously illustrated by taking two or three pounds of damp cotton in his hand, and plunging a red-hot poker into it. Thus gun cotton damped with a proper amount of carbonate of soda solution may be transported without risk to any part of the world, and may then be easily dried for use; and it is a curious fact that while raw cotton requires a temperature of not less than 240° F. to drive off all moisture, gun-cotton becomes perfectly dry at about 180° F.—the heat required to explode being 300°.

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* 'Proceedings of Royal Society,' vol. xv., p. 417.

† 'Quarterly Journal of Science,' vol. i., p. 407.

Gun cotton is however hygroscopic, and on this account has been found uncertain when made into cartridges. A sportsman, for example, would make good shooting in the early part of a damp day, bad in the middle, and worse in the afternoon. This objection to the use of gun cotton, so much to be recommended on other accounts for sporting purposes, has been obviated by the Messrs. Prentice, who now enclose each charge in the thinnest possible coating of india-rubber, by which the access of moisture is completely prevented.

Of two other important papers communicated to the Royal Society we can only give the titles. The first is by Mr. H. C. Sorby, "On a Definite Method of Qualitative Analysis of Animal and Vegetable Colouring Matters by means of the Spectrum Microscope."* This is really a continuation of the experiments described in an article in our own pages,† made with improved apparatus and a more definite aim. The paper requires very careful reading at length for the full understanding of its contents. While on this subject we may refer the reader interested in the matter to a valuable paper by M. Preyer, "On the Quantitative Determination of Colouring Matters of the Blood by means of the Spectroscope."‡

The next is a paper by Sir B. Brodie, read May 3rd, and entitled "The Calculus of Chemical Operations: being a Method for the Investigation, by means of Symbols, of the Laws of the Distribution of Weight in Chemical Change." For this, which will be a sealed book to all but chemists familiar with the higher branches of algebra, we must refer the reader to the original paper in the 'Philosophical Transactions,' or a useful abstract in the 'Chemical News' for May 31st.

A few processes of technical interest have been brought to notice within the past quarter. Among these is one by Stolba, for easily obtaining Sulphurous Acid on a large scale. When sulphate of iron or sulphate of copper is heated with sulphur, sulphurous acid is given off, and the sulphate is reduced to sulphide:—

$$FeO, SO_3 + 2\,S = Fe\,S + 2\,SO_2.$$

To carry out this process practically, two-and-a-half parts of dry sulphate of iron are mixed with one part of sulphur, and heated in an iron retort, provided with a tolerably wide exit tube. This process perhaps may be made available in some manufactures.

A great advance has been made in the manufacture of aniline dyes by MM. Girard and De Laire, who have succeeded in extracting three new dyes from the residues of the manufacture of rosaniline, in which one half the aniline employed has hitherto been wasted. They name the bases of these colours Mauvaniline, Violaniline, and Chrysotoluidine. The methods by which these are separated are described in the place indicated below.* The manufacture has been patented in France, and probably also in England.

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* 'Proceedings of Royal Society,' vol. xv., p. 433.

† Vol. ii., p. 98.

‡ 'Annalen der Chemie u. Pharm.' Bd. 140, p. 187.

A new blue has also been patented in France, by the same gentlemen. It is made by heating, under pressure, a mixture of commercial aniline (aniline and toluidine) and hydrochlorate of the same aniline with terchloride of carbon. The result is a bronze-coloured mass, which is purified by first treating it with benzol or petroleum, which will leave the dye undissolved; then dissolving in wood-spirit or alcohol, and finally precipitating with hydrochloric acid.

In connection with Technical Chemistry, we may mention a paper of interest "On the Waste of Materials in the Alkali Manufacture,"† by Mr. James Hargreaves.

In this and the one mentioned subsequently in our report of the proceedings of the Chemical Society, the alkali manufacturer will find valuable information.

A fact of much interest to the chemist and geologist observed by M. Daubrée deserves a passing notice. Felspar reduced to the finest powder does not give the faintest alkalinity to water. But M. Daubrée finds that fragments of felspar violently agitated with water will give up to the water as much as two per cent. of the potash it may contain. The author sees in this an easy means of obtaining an alkaline water for washing linen; but at the same time remarks that it may throw some light on the changes which are taking place on the surface of our earth.

Some important contributions to analytical chemistry have also been made. A noteworthy paper, "On Pugh's Method of Determining Nitric Acid," has been published‡ by MM. Chapman and Schenck.

This method, which has specially recommended for the determination of nitric acid in water, has been found by the authors to be altogether faulty under the conditions in which it is likely to be employed. The method will be well known to all our chemical readers, and therefore we need only say, that in the presence of nitrogenized organic matter, the authors have found it to be simply valueless, inasmuch as such bodies as albumen, gelatine, and urea, all yield ammonia when digested with protochloride of tin.

Some analytical notes on Cadmium, by Wohler,§ give methods of separating this metal from zinc and from copper. To separate cadmium and zinc, the author adds a large excess of tartaric acid, then renders the solution strongly alkaline with caustic soda, and boils for several hours. Cadmium only is deposited.

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* 'Bulletin de la Société Chimique de Paris,' May, 1866.
† 'Chemical News', vol. xv., pp. 219–232.
‡ 'The Laboratory,' No. 9, p. 152.
§ 'Chemical News,' vol. xv., p. 166.

To separate the sulphides of cadmium and copper, the author dissolves in hydrochloric acid and adds chlorate of potash. The solution may then be treated as above, and the copper recovered from the filtrate, by first oxidizing aqua regia, and then precipitating with caustic potash.

Dr. R. Wagner gives * a "Hydrostatic test for the detection of Paraffin in Bees' Wax." The specific gravity of pure bees' wax, he finds to be from 0·965 to 0·969; and of commercial paraffin from 0·869 to 0·877. Mixtures of the two will of course give intermediate gravities; and in the author's experiments the results closely agreed with those required by calculation. Pure bees' wax, it is added, should sink in spirit of wine, sp. gr. 0·961: if the wax should float, the presence of paraffin may be suspected.

The same author gives a ready means of detecting stearic acid in paraffin. An alcoholic solution of neutral acetate of lead gives no precipitate in a boiling alcoholic solution of paraffin; but if stearine is present, a turbidity or flocculent precipitate is produced.

Dr. Wagner also shows that the density of a specimen may afford some information on the probability of the adulteration of oil of bitter almonds with nitrobenzol. The former has the sp. gr. 1·040–1·044, the density of ordinary nitrobenzol varies from 1·180 to 1·201. A better test, however, is a strong solution of bisulphite of soda, with which genuine oil of bitter almonds forms a crystalline mass. On carefully adding a little water, the nitrobenzol will float on the surface.†

PROCEEDINGS OF THE CHEMICAL SOCIETY.

At the meeting on March 7th, Mr. E. T. Chapman read a paper "On the Oxidation of Formic Acids." This acid, unlike those of the acetic and aromatic series, the author has found does not resist the oxidizing action of a solution of chromic acid, which converts it into water and carbonic acid.

Dr. Dupré afterwards read a "Note on the Synthesis of Formic and Hyposulphurous Acid." Formic acid is produced by the action of sodium on carbonic acid. Reasoning from analogy, the author supposed that hyposulphurous acid would be formed by the action of sodium on sulphurous acid, a prevision which experiment confirmed. Dr. Dupré is thus led to regard hyposulphurous acid as

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* 'Zeitschrift für. Analyt. Chem.,' 1866, p. 279.

† Ibid., p. 285.

the formic acid of the sulphur series, and suggests that the atomic expression may be simplified by halving the common formula thus:—

$$Na_2H_2S_2O_4 = 2\ (Na\ H\ SO_2).$$

An interesting conversation followed the reading of these two papers, in the course of which Dr. C. Calvert mentioned that in making formic acid by the oxalic acid and glycerine process, he had observed that the acid was produced slowly at first, but that on adding a fresh quantity of monohydrated oxalic acid, the action went on very regularly. Dr. Odling suggested that this might be explained by the supposition that a formiate of glycerine was first formed, and subsequently decomposed. Mr. Chapman thought that an oxalate of glycerine was first produced, which, under the influence of heat, split up into formic and carbonic acids, the glycerine being regenerated. Referring to Dr. Dupré's paper, Mr. Chapman added that he could not allow that sulphur played the part of carbon, or that there was any analogy between formic and hyposulphurous acids.

Dr. F. C. Calvert then gave a short account of some experiments, in the course of which he had found that a large proportion of the mineral phosphates in cereals, peas, beans, and also cotton, could be extracted by digestion in water.* Such solutions always contain much magnesia.

Mr. Spiller reminded the audience of an experiment of Dr. Hofmann, who used to show that the addition of ammonia to infusion of malt or pale ale always produced a precipitate of ammonio-magnesian phosphate.

Dr. Calvert then described some results obtained by the action of charcoal impregnated with oxygen, a longer account of which was given at a subsequent meeting.

On March 21st, Dr. Gladstone read a paper "On Phosphonitril," PNO, a white solid, produced by heating the product of the action of ammoniacal gas on the oxychloride of phosphorus, and which has been described before under the names "*phosphamide*" and "*biphosphamide*,"—names obviously inapplicable since the body contains no hydrogen. Dr. Gladstone therefore proposes the new name, *phosphonitril*, a designation which met with the approval of Mr. T. Sterry Hunt, who had fifteen years ago described it as the nitril of phosphoric acid.

Mr. J. Parkinson then read a paper "On Phosphide of Magnesium," Mg_3P, formed by heating magnesium with phosphorus in an atmosphere of hydrogen. Phosphide of magnesium rapidly decomposes water, forming phosphide of hydrogen and oxide of magnesium.

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* It has long been known that the washings of starch manufacture contained a large quantity of phosphates, and they have consequently been recommended for manure.

At the same meeting, Dr. Squire exhibited a specimen of "frozen glycerine," imported from Germany, which attracted much attention, glycerine being reputedly non-congealable. It was said that no sugar or other crystallizable matter could be detected in the specimen.*

The annual meeting of the Society was held on March 30th. We need only mention that the Report showed the increasing prosperity of the Society, and contained a notice that the Council had under their consideration a proposal for raising the standard of qualification for the Fellowship.

On April 4th, Dr. Calvert's paper "On Oxidation by means of Charcoal" was read. The author experimented with freshly burnt charcoal saturated with oxygen. Such charcoal quickly changed sulphurous into sulphuric acid, and sulphide of hydrogen into water and sulphuric acid. The vapour of common alcohol diffused in oxygen was converted into acetic acid, and anylic alcohol similarly into valerianic acid. Many other bodies were experimented with, but the results obtained are not yet accurately made out. Dr. Calvert speculates that the condensation of oxygen and other gases within the pores of the charcoal amounts to actual liquefaction.

The President referred to the condition of some solid bodies—metals, for example, under great pressure, when they seemed to behave like liquids, a subject which has lately received further illustration at the hands of M. Tresca.

On April 18th, Mr. J. Spiller read a paper, entitled "Observations on the Weathering of Copper Ores." The paper referred to the action of air and water on some Devonshire ores containing mundic, spathic iron ore, mica-schist, and copper pyrites. The experimental observations showed that not only sulphate of copper is produced by the action of air and moisture, but that secondary reactions occur in the presence of spathic iron, aluminous schist, and other minerals, the metallic bases of which are converted into sulphates at the expense of an oxidized portion of the sulphur in the original ore. Mr. Spiller obtained some of his results by an examination of the water of a stream in which the ore referred to was washed; and he points out the advisability of adding lime or chalk to such water to avert the ill-effects of water so impregnated with mineral poison on the meadows irrigated by it.

Professor A. H. Church, who had visited the locality, referred to the poisonous effects of the sulphates of copper, iron, and manganese on vegetation, and mentioned that while the stream above the workings was full of water-weeds, they, as well as fish, disappeared immediately below.

At the same meeting, a paper by Messrs. E. T. Chapman and

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* Mr. John Williams has since found a considerable amount of sulphate of soda in a portion of the quantity imported.

M. H. Smith, "On the Oxidation of Acids of the Lactic Series," was read; and also a note by the same authors, "On Limited Oxidation by Alkaline Permanganate." In this latter paper the authors pointed out the differences in the products of the oxidation of common alcohol by acid, and by alkaline permanganate. In the former case, acetic acid and aldehyde are produced, while in the latter nothing but oxalic acid is obtained. Lactic acid gave similar results. The authors pointed out a means of distinguishing between citric and tartaric acid by the use of a strongly alkaline solution of permanganate. Citric acid only carries the reduction to green manganate, while with tartaric the reduction to brown hydrated binoxide is complete.

A paper, by Dr. F. C. Calvert, "On the Presence of Soluble Phosphates in Cotton Fibre, Seeds, &c.," was afterwards read. The author's experiments have led him to the conclusion that the whole of the phosphoric acid or phosphates is merely held mechanically distributed through the organic tissue, and may be wholly extracted by the action of water. He showed that cotton yarn steeped in water yielded a solution containing phosphoric acid, lime, and magnesia. Wheat, French beans, and walnuts gave similar results.

The meeting on May 2 was occupied with a discussion, originated by Dr. Odling, on the use and misuse of the term "atomicity." The discussion was continued by Professors Williamson and Miller, who advocated the substitution of the term "equivalence," and by Dr. Thudicum, who has proposed the word "dynamicity." For a full report of this interesting discussion we must refer our readers to the Chemical Journals.*

The last meeting we can notice was held on May 16. At this Mr. W. H. Perkins, F.R.S., made an interesting communication on the artificial formation of Coumarine. This substance, which was discovered by Delalande in the Tonquin Bean, has the formula $C_9H_6O_2$. When gently heated with a solution of caustic potash it assimilates water, and becomes coumaric acid, $C_9H_8O_3$; but when fused with hydrate of potash it splits up into salicylic and acetic acids. Mr. Perkins has found that by acting on the sodium compound of hydride of salicyle with acetic anhydride, he obtains a product completely identical with coumarine. The full details of the experiment the author reserves for a future communication.

The Secretary then read a paper by Professor Rammelsberg, "On the Constitution of the Phosphites."

The next paper was by Dr. Dupré, "On the Changes in the Proportion of Acid and Sugar in Grapes during the progress of Ripening." The author's experiments go to show that the amount of acid varies but little during the progress of ripening, while, of course, the proportion of sugar greatly increases. His inference is that the acid is not converted into sugar; although it may assist in the production.

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* 'Chemical News,' May 10, 1867.

The next paper, "On the effects produced by the addition of Plaster of Paris to Must," was also read by Dr. Dupré. Wherever wine is made, the makers have the habit of adding plaster of Paris to the grape-juice either before or during the progress of fermentation. The author showed that the effect of this was to remove some of the tartaric, leaving the malic acid, and to introduce into the wine sulphates of potash and lime. He believes wine to be greatly deteriorated by the addition.

A description of "An Adapter to be used in connection with a Sulphuretted Hydrogen Apparatus," contrived by the Rev. B. W. Gibsone, was then given by the secretary. For this we must refer our readers to the Chemical Journals.

A valuable paper, "On the Practical Loss of Soda in the Alkali Manufacture," by Mr. C. R. Wright, was then read. The total loss in the process of converting common salt into refined ash is estimated by the author at 24 per cent. Mr. Wright has determined the amount of loss at different stages of the process, and his communication, when published at length, will afford valuable information to all manufacturers of soda.

6. ENGINEERING—CIVIL AND MECHANICAL.

The recent depression in engineering enterprise, consequent on the financial crisis of last year, has not yet recovered so far as to give any impetus to the prosecution of new undertakings. It is true that most descriptions of security have experienced a considerable rise in marketable value, but the public mind has evidently not yet sufficiently recovered from the shock it had received to enable it to look favourably on fresh enterprises as a means for investment, and consequently but few new works of any magnitude have at present any chance of finding supporters in the public money-market. At the same time, the cheapness of money and the abundance of floating capital seeking investment have been sufficient to provide for the completion of many works previously in course of construction. But this has not invariably been the case. The works of the Waterloo and Whitehall, and of the Metropolitan District Railways, are at present at a standstill, and doubtless many other promising undertakings are similarly languishing for want of funds.

Amongst the lines of railway recently completed may be mentioned the Chemin de Fer du Ceinture at Paris, which was opened for passenger traffic throughout on Monday, the 25th February last. This line is 22 miles in extent, and almost completely encircles Paris within the fortifications. The Calais and Boulogne Railway was opened for passenger traffic on the 1st April, and by it half-an-hour is saved in the journey between Paris and London. The Charente Railway Company has opened a section from Rochefort to Saintes, and the Northern of France Company has opened a line 73 miles in length from Amiens to Rouen. At the commencement of the present year, the length of railway open in Spain was 3,182½ miles; the distance in course of construction was 356⅞ miles, and 512½ miles remained still to be commenced out of the lines conceded. The total extent of railways in Italy at the close of last year was 2,572 miles, 404 miles having been opened in the course of 1866. A line from Civita Vecchia to Nanziatella, which is to unite the Leghorn line to Rome viâ the Marennes, is now ready for traffic. Among the works especially deserving of notice on this line, are bridges over the Mignone, the Marta, the Arone, and the Fiera. By the transfer of Venetia to the kingdom of Italy, the network of Italian railways has been increased to the extent of 600 miles. An uninterrupted line of railway has now been established on the eastern side of the Italian Peninsula. The opening of the line from Ancona to Foligno and Rome, puts the North in communication with Naples, and Florence has now also uninterrupted railway communication with Rome. In Russia, surveys for great lines uniting the Baltic to the Black Sea and the Caspian Sea are expected to be pushed forward; several applications have recently been addressed to the Russian Government for new lines, either from foreign or domestic capitalists. At the close of last year 885⅝ miles of railway were decreed in Holland, of which 616⅞ miles were in operation, while 193¾ miles were in course of construction, leaving 75 miles still to be constructed. In the course of 1866, about 110 miles of line were opened for traffic. In India there has recently been opened a further section of the line between Bombay and Calcutta, leaving only 200 miles yet to be completed in order to unite those two capitals. A section of railway between Delhi and Meerut was opened on the 15th of April; and a branch railway between Lucknow and Cawnpore was opened on the 23rd of April last. Trains have also within the last month commenced running on the Ceylon Railway.

A new bridge has recently been completed on the Rhine between Manheim and Ludgwigshafen, consisting of three openings of 290 feet span each, and a project has been brought forward for the construction of another great bridge over the same river, near Dusseldorf.

The Hoosac tunnel, the largest work of the kind yet attempted in America will be about 4½ miles in length, and its sectional area 459 square feet. Only 4,600 feet, of about half the full section, has yet been penetrated at both ends; the central shaft is to be 1,030 feet deep; the tunnel itself is elliptical in section, 27 feet by 15 feet, and is now down 400 feet.

The quay walls of the new Windmillcroft Dock on the Clyde were completed early in March last; this dock is 1,050 feet long by 250 feet broad, and has an area of rather more than 5 acres. The Norfolk Estuary Company have very recently completed another embankment of two miles in length at North Wooton, by means of which 700 acres has been added to that already reclaimed in the Wash, and makes a total of about 4,000 acres of the 32,000 to be recovered from the sea by that Company. We are informed that, after extensive soundings, Mr. Hawkshaw has abandoned his project for a submarine channel railway between England and France; and from a contemporary journal we observe that it is intended to make a subaqueous tubular bridge across the bed of the Mississippi at St. Louis, at which point the river is about half-a-mile broad.

A great deal of progress is just now being made in the construction of telegraph lines, especially submarine. The Electric Telegraph Company have laid a second wire to the Isle of Wight; and a fresh cable has been laid between Hull and New Holland. In January last a submarine cable, 29 miles in length, was laid between Ceylon and the main land, being the first yet constructed on Mr. Hooper's principle, which principle has, we observe, obtained a gold medal at the Paris Exhibition. A contract was, not long since, signed with the Telegraph Construction and Maintenance Company for a submarine cable between Placentia, Newfoundland, and Sydney, Nova Scotia; and Messrs. Silver and Co. have recently manufactured a cable, 110 miles in length, for submergence between Florida and Cuba. The works on the Russo-American line have, it is stated, now been abandoned. An iceberg recently grounded within a mile-and-a-half of the Newfoundland coast and cut the new (1866) Atlantic cable, so that the old cable had for some time all the work to do by itself, but the fracture has now been successfully repaired. Before leaving the subject of telegraphy, we may notice that the Government have in preparation a scheme for acquiring a right over the whole of the telegraph lines throughout the United Kingdom, and to work them in connection with the Post Office. A bill for this purpose will be introduced as soon as the Reform Bill has been sent to the Upper House.

The use of steel in locomotive construction is beginning to be more thought of than heretofore. There have been now at work for some years, on the Maryport and Carlisle Railway, several locomotives having steel boilers, fire-boxes, and tubes, as well as steel tyres, piston rods, and motion bars; and there have recently been constructed for the Paris and Sceaux line, and for the Southern Railway of France, several engines with steel boilers. The use of punched steel gun-barrels is rapidly extending, and the principle introduced by Messrs. Deakin and Johnson is being applied to other purposes connected with machinery. Bessemer steel is now beginning to be used for bridge construction, and it is stated that a recent French invention is likely to be able to compete successfully with the Bessemer process for the manufacture of steel. It may be accepted as a general belief that the age of iron is gradually passing away, and that in most cases where it is now employed, steel will shortly take its place, as being both stronger and lighter.

The use of water-tube boilers may be classed as one of the inventions of the day, their increased strength and security contributing greatly to their popularity. Messrs. Howard, of Bedford, have recently tested their water-tube boilers to a pressure of 1,000 lbs. per square inch.

It is reported that in America very heavy guns are now worked entirely by steam. A centrifugal gun has been invented by Dr. Steinheill, which, it is asserted, will throw from 60 to 100 bullets a minute, but the power necessary to obtain that result is not clearly stated. Major Palliser has been awarded 15,000*l.* for his pointed, or ogival-headed chilled shot, and in consequence of their great power of penetration experiments have lately been made of the manufacture of armour-plates having a steel face welded to an iron body, and of plates formed of alternate layers of iron and steel, with a view to obtaining greater strength without increasing the weight.

7. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

The subject which of all others has attracted the interest of not only the Royal Geographical Society, but also of all who interest themselves in the annals of enterprise, is the probable fate of Dr. Livingstone. Some time since Dr. Kirk wrote from Zanzibar, giving a graphic and, as it seemed at the time, a probable account of the murder of the enthusiastic traveller by a warlike tribe on the western side of the lake Nyassa. The story was derived originally from certain Johanna men who had been with Dr. Livingstone, but who returned without him. Bit by bit the weak points of the account came out. The tale depended upon the evidence of one man, Moosa, who has proved unworthy of credit, inasmuch as he has since given another version of the same event; a white man is reported to have been travelling amongst more distant tribes, and Dr. Livingstone himself is said to have been heard of by a caravan of merchants as having passed the spot of his supposed death and as making onwards inland. At the instigation of the Royal Geographical Society, an expedition is to be assisted by the Government, and the men who undertake this work will accomplish something, whether they discover any traces of the former traveller or not. They take with them a steel boat in portable pieces, which will be launched on these mighty lakes, and which will assist in the solution of some of the problems connected with them. The loss of Dr. Livingstone, if he prove to be dead, is undoubtedly a great one, and much to be regretted; at the same time a fictitious excitement has been caused by the publication of unsifted scraps of information which only serve to add conjecture to conjecture.

As to other parts of Africa, M. de Sainl in the centre, and Professor Freilli in the north, are making attempts to penetrate the interior. The detention of the captives in Abyssinia still continues, and Dr. Beke has published a second edition of his work* on that country, with remarks on the late proceedings. Naturally he condemns the diplomacy which has brought such deplorable results, and which was opposed to his advice. An account of Madagascar† by a missionary gives a fairly full description of the people, who seem to be advancing towards civilization at a tolerably rapid rate.

The Russian Government has been giving full employment to its topographical corps in surveying and mapping out their newly-acquired territories in Manchuria and the neighbouring states, so that the whole of the southern border of the empire is now delineated on a scale suited for practical purposes. Whilst Russia is thus advancing upon China from the north, the Government of India is having surveys of much of the country between Burmah and the Celestial Empire, whilst an endeavour is being made to bring the provinces formerly in dependence on China, but now independent, into commercial relations with northern India. Viscount Pollington has traversed some portion of Central Asia, and has written a book,‡ which however does not contribute much to our previous knowledge.

Dr. I. I. Hayes, the Patron's Medalist of the Royal Geographical Society this year, has written an excellent book on his late expedition among the Esquimaux. His opinion, as well as that of M. Gustave Lambert, backs that held already by many German and English geographers, and advocated in former numbers of this journal, that there is open sea towards the North Pole. The last-named gentleman advocates the attempt by Behring's Straits, and urges his own countrymen to carry off the glory of the discovery from other contending nations.

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* 'British Captives in Abyssinia,' by Chas. T. Beke, Ph.D. Longmans.

† 'Madagascar Revisited,' by the Rev. H. Ellis. Murray.

‡ 'Half Round the Old World.' Moxon.

A Peruvian expedition has been exploring the south-western tributaries of the Amazons with some success. Several of these rivers have been found navigable; but the tribes amidst which they flow are cannibal and bellicose. The explorers arrived within 400 miles of the Pacific coast, and it is hoped that it will be possible, by means of a railway, to open up traffic between the two oceans. The fish of this mighty stream and its tributaries have been subjected to the researches of Professor Agassiz. He finds in the main stream as many as 2,000 different species, several of which are highly useful. Of these, nearly 200 kinds—more than the whole Mississippi can produce—were to be obtained within a few yards of one another.

According to an American paper, an attempt has been made—which however was not entirely successful, even if we trust the high-flown language of the traveller who narrates it—to ascend Orizaba, the highest mountain in Mexico, close to one of the last places of retreat of the unfortunate emperor. Very accurate numbers are avoided by the writer, but he professes to have advanced to a greater height than 16,000 feet, when the party was stopped by the general fatigue, and by the fall and injury of their leader. Farther north the great lakes are affording a problem not easy of solution. The huge stream of the St. Lawrence flows from them, but they are fed by only a few insignificant streams. Whence comes all this body of water? Is it from subterranean sources? and if so, where can so vast a drainage be collected?

Mr. E. Whymper, of the Alpine Club, is going to Greenland to try whether his experience in Switzerland will enable him to make some ascents of mountains which will give more scientific results than those commonly undertaken by members of the club.

In Europe but little has taken place of geographical interest, except that the volcanic system of the Mediterranean has been for some little time in a state of considerable activity, giving indications of changes in the earth's surface. A good account of the Sclavonic provinces of Turkey is given by Messrs. G. Muir Mackenzie and A. P. Irby* in a heavy but useful book.

In anticipation of the medals of our own Society being given to foreigners, the Geographical Society of Paris has presented Sir Samuel Baker with its gold medal for the current year. The Academy of Sciences has elected M. d'Abbadie to the chair of Geography after a close contest. A sum of 4,000 francs has been laid aside by Mme. Guévineau, sister of the traveller Lalande, to be presented to the traveller who shall have been most instrumental in improving human food.

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* 'The Turks, Greeks, and Slavons.' Bell & Daldy.

We would call attention to the following works on Geography lately published:—'Géographie de Strabon,' traduction nouvelle par Amédée Tardieu. Duarte Barbosa's 'Description of the Coasts of East Africa and Malabar in 16th Century,' translated by the Hon. H. E. J. Stanley. A kind of geographical novel, called 'Wild Life among the Pacific Islanders,' by E. H. Lamont. The three following German works,—'The Prussian Expedition to Eastern Asia, from Official Sources,' a good account of Japan, &c.; L. Hacker's 'American Sketches;' Dr. H. A. Pagenstecher's 'Sketches of the Balearic Islands;' Shepherd's 'North-west Peninsula of Iceland;' and 'L'Année Géographique' of V. de Saint-Martin. The second edition of Kiepert's 'New Hand-Atlas of all Parts of the World,' in forty-five sheets, is worthy of mention, on account of its accuracy, clearness, fullness, and cheapness.

PROCEEDINGS OF THE ROYAL GEOGRAPHICAL SOCIETY.

At several meetings of the Society since our last report the probable fate of Dr. Livingstone was discussed, a subject which our readers will find fully treated elsewhere. The first paper we have to notice is one by Admiral A. Boutakov, of the Russian navy, who has since received the Founder's Medal for the discoveries therein described. The gallant traveller surveyed the Delta of the Oxus, in the Sea of Aral, and was the first to launch a boat in that little-known lake. If we are ever justified in arguing from silence, this lake did not exist in so-called historic times, that is to say, during the period in which we have authentic works on geography, &c., written in Europe. No description of this sea occurs in European writers, nor did Asia furnish writers who could give details sufficiently explicit. In the way of positive testimony in the other direction, the Oxus and Jaxartes are said by Arabian geographers from the 13th to the 15th century to empty themselves into the Caspian, though previously the sea of Aral existed much as it does now. The several mouths of the Oxus all appear to be extremely shallow, and to afford but small advantages to a commerce that would at all times be liable to be interrupted by hostile tribes.

A map of Chinese Tartary, founded on the Russian surveys and on the map of caravan routes made by Colonel Walker, of the Indian Trigonometrical Survey, was exhibited by Captain Sherard Osborn, who also added a description of the country as far as it is at present known. It divides itself into three principal divisions—Manchuria, Mongolia, and Ili, or Eastern Turkestan. The former of these belongs in part to the Russians, who in all probability will get the whole before very long, when they will be better able, by means of the various river valleys, to communicate with the settlements on the coast and with the eastern seas, from which they are now cut off by a range of mountains. Mongolia is at present the home of Mussulman cut-throats who overrun the neighbouring provinces, unchecked by the supineness of the Chinese Government. The third portion, Ili, is divided by a range of mountains. This district, interesting from the many ancient cities to be found within its borders, approaches that region of Central Africa which promises most to the enterprising traveller. In these regions the advancing powers of Russia and England will some day meet, and it remains to be seen whether, advancing gradually as the countries throw themselves into our hands, we may meet as friendly allies, warring alike and in common against Oriental tyranny and iniquity, or whether with the grasping spirit engendered by too great a devotion to commerce we coerce unwilling tribes and with unsettled borders encounter a warlike nation ready to wrest our ill-gotten gains from our hands. Other papers that have been read lately have been:—"A Trip to the Sources of the Sutlej," by Captain H. U. Smith and Mr. J. S. Harrison, M.A.; "On Part of Mesopotamia contained between Sherial-el-Beytha, on the Tigris, ten miles N.W. of Baghdad, to the large mound Tel-Ibrahim, nearly in the centre of Mesopotamia, nineteen miles N.N.E. of Hillah," by Lieutenant J. B. Bewsher; "On the Discovery of the Sources of the Lycus, the site of Nicopolis and other places in Kurdistan," by Mr. Consul Taylor; "A Description of Diarbekr," by Mr. R. J. Garden.

The anniversary meeting of the Society took place on the 27th of May. The report of the year describes the increase in the number of Fellows, and consequently of funds, the large additions to the library, both in the way of books and of maps, and the mode in which various sums had been expended in the advancement of geographical science. The Founder's Medal was bestowed on Admiral Alexis Boutakov, of the Russian Imperial navy, whose researches on the Sea of Aral are epitomized above, and the Victoria or Patron's Medal was given to Dr. I. I. Hayes for his researches in Arctic regions, where he reached a point farther north than any of his predecessors on land. In a simple, unpretending manner these researches are chronicled in his work on the 'Open Polar Sea.'

The President's Address was chiefly occupied with what has taken up so greatly the time of the Society during the present session, *viz.* the discussion of the probabilities in favour of the life or death of Dr. Livingstone, as reported by the man Moosa.

8. GEOLOGY AND PALÆONTOLOGY,

(Including the Proceedings of the Geological Society.)

An account of a most important work, entitled 'Thesaurus Siluricus,' was read by its author, Dr. Bigsby, before the Royal Society, on February 21st, and has since been published in the Society's 'Proceedings.'* This 'Thesaurus' is a catalogue of all the fossils which have been described from Silurian deposits in all parts of the world, and gives the range of each species in space and time. In the summary of results now made public are many facts and conclusions which are important, and some which are curious; but all are interesting. We thus find that there are 3,145 known American Silurian species and 4,325 European; but only 179 are common to the two regions. The Primordial Zone is the first formation in which anything like a *fauna* has been discovered, and in this deposit we suddenly become conscious of the creation of more than 900 species, belonging to a majority of the classes of the Invertebrata. Species are treated of by the author under two aspects, namely, (1) as being typical of one horizon; and (2) as "recurrent," or occurring in more than one. He finds that 12 per cent. of the whole number of species occur in more than one horizon, and that "the same species may be typical of one horizon in one country and recurrent in another." All these recurrents are, of course, within the limits of the Silurian epoch, and Dr. Bigsby treats of them as intra-epochal. Those species which pass into the Devonian period are termed extra-epochal, and he has been able to identify 42 which come under this head; and only one of these (*Chonetes sarcinulata*) is known to have survived in Carboniferous times. It is worth notice, also, that these extra-epochal recurrent species were of migratory habits,—"few being found in two epochs in the same country, but in different countries."

We are glad to learn that the Royal Society has granted 100*l.* towards defraying the cost of publishing this work, and we look forward to its appearance with some impatience. It is only by such laborious endeavours as this that we can hope to discover the laws which have regulated the appearance and extinction of species during geological time.

A very remarkable paper "On the Miocene Flora of North Greenland," by Professor Oswald Heer (translated by Mr. R. H. Scott) has been published in the Journal of the Royal Dublin Society. The collection of fossil plants described in the paper was brought from the Arctic regions by Captain Philip H. Colomb, R.N., and Sir Leopold M'Clintock, R.N., and contains 63 recognizable species. It is therefore quite trustworthy as to locality, and sufficiently extensive to furnish valuable evidence as to climate. All the specimens, moreover, in this and other collections, came from one locality —Atanekerdluk,—which is in lat. 70° N., and were obtained from a deposit occurring at a height of 1,080 feet. Professor Heer is of opinion that the leaves "cannot have been drifted from any great distance," but that the plants grew on the spot where their remains are found. Three species had been previously mentioned by Brongniart and Vaupel, making with those now recognized a total of 66. Of these, 18 are found in the Miocene deposits of Central Europe, 9 being common to the Upper and Lower Molasse, while four species have not as yet been noticed in the Upper Molasse. The author therefore infers "that the fossil forest of Atanekerdluk flourished in that high northern latitude at the Lower Miocene Epoch," and that North Greenland had a much warmer climate during the Miocene period than it has at present. The extent to which the present temperature of the region would have to be raised, to render possible the existence there of such plants as those described in the paper, is estimated by Professor Heer at about 30° F. Most stress is laid on the presence in the collection of two species of *Sequoia*, one of which (*S. Langsdorfii*) is found fossil in as low a latitude as that of Central Italy, and is the commonest tree at Atanekerdluk; it is also "so closely allied to the *Sequoia sempervirens* of Lambert (the 'Redwood'), that we may consider the latter as its lineal descendant." Now this tree, we learn, "requires for its existence a summer temperature of at least 59° or 60° F., and for the ripening of its fruit and seeds one of about 64°." The winter temperature must not fall below 31°, and the mean annual temperature must be about 49°. The climate of Greenland must therefore have been at least as warm as that of Lausanne, and was probably somewhat warmer. These facts are at the present time of peculiar importance, and are recognized as being so by Professor Heer, who avows his belief "that it is impossible, by any re-arrangement of land and water, to produce for the northern hemisphere a climate which would explain the phenomena in a satisfactory manner;" and he concludes his paper with the remark "that we are here face to face with a problem whose solution, in all probability, must be attempted, and we doubt not completed, by the astronomer."

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* Proc. Roy. Soc., No. 90, 1867, p. 372.

In a paper "Ueber die Parallelisirung des norddeutschen, englischen, und französischen Oligocäns, published in the last number of the 'Zeitschrift' of the German Geological Society, Herr von Koenen returns to the discussion of his favourite topic, for the purpose of disputing the conclusions arrived at by M. Hébert in a paper on the Nummulitic beds of Northern Italy, published last year in the 'Bulletin' of the Geological Society of France. The two papers may be taken as respectively typical of the German and French schools of Tertiary geologists; but until we have some generally accepted principles of Tertiary classification, it will be impossible to come to any agreement on the subject of the German Oligocene, which we have already discussed in this Chronicle on several occasions.*

In the last volume (vol. xix.) of the 'Mémoires de la Société de Physique et d'Histoire Naturelle de Genève,' MM. de Loriol and Pellat have published an elaborate essay, entitled "Monographie paléontologique et géologique de l'étage portlandien des environs de Boulogne-sur-Mer," in which is given a complete history of the events which, according to the views of the authors, took place during the deposition of the Portland Oolite. It is especially worthy of remark that they regard the "Portlandien inférieur" of the eastern districts as synchronous with the Lower and Middle Portlandien of the Boulonnais; that is to say, that a Lower Portland fauna continued to live in the eastern regions after the fauna of the Portland stone of England, and its equivalents in the Boulonnais and the Pays de Bray, had supplanted it in the west.

In the 'Bulletin de la Société géologique de France' (vol. xxiv. No. 2) M. Thomas records the discovery of a lower jaw of Rhinoceros in the Upper Eocene of Tarn, near Gaillac. The author states that this genus has not hitherto been found in beds more ancient than the Miocene; and he demonstrates the greater antiquity of those in question, by showing their connection with the deposits of the basin of the Agout, where M. Noulet has discovered remains of *Lophiodon Lautricense*, *Palæotherium magnum*, *Paloplotherium minus*, and *P. annectens*. He regards this Eocene species as being very nearly allied to, if not identical with, the *Rhinoceros minutus* of Cuvier. It may be useful to remark that remains of *Rhinoceros* had previously been obtained from Eocene deposits in more than one locality in France, although M. Thomas seems to have been unaware of the fact.

The Geological Commission of Portugal has recently published two important volumes. Of one, entitled 'Descripção do solo Quaternario das Bacias Hydrographicas do Tejo e Sado,' by M. Carlos Ribeiro, we can only say that it is a very exhaustive treatise on the various Quaternary deposits of the valleys of the Tagus and the Sado, some of which have yielded remains of human industry. The other is, so far as we know, the first palæontological work of importance ever published in Portugal, and is entitled 'Gasteropodes dos depositos Terciarios de Portugal,' by M. Pereira da Costa. As the descriptions of the other fossils are to be published afterwards, the author reserves his conclusions until the completion of the work; but it is noteworthy, that he finds it necessary to preface this part with an introduction describing the objects of Palæontology, and the course he has adopted in his descriptions of the fossils. Both works are printed in double columns, of which one is in the Portuguese language, the other being a translation in French.

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* Quart. Journ. Science, No. iii., p. 480; No. ix., p. 100; No. x., p. 279.

We have pleasure in recording the publication of the text to the volume of plates forming Part I. of M. Barrande's "Cephalopodes Siluriens de la Bohême," which we noticed in our Chronicle in No. IX.

In the 'Annales des Mines' (vol. x.) is a welcome note on the "Geology of the North of Madagascar," by M. E. Guillemin, from which we learn the existence of a coal-bearing series of deposits on the north-west coast belonging to the Carboniferous formation, and probably to the Mountain-limestone; but it appears that the beds of coal seen by the author are of inconsiderable thickness.

In a report by Dr. Sterry Hunt and Mr. A. Michel, of the Geological Survey of Canada, on the Gold-region of Hastings, Upper Canada, the occurrence of gold in rocks of Laurentian age is proved beyond a doubt. This discovery still further enlarges the list of gold-bearing formations, but as we cannot find any expression of opinion by the authors as to the geological period of the impregnation, this the more scientific aspect of the question is left open.* The gold has been found in "three different associations: first, in the black carbonaceous matter; second, in the reddish ochery (*sic*) oxyd of iron, which is found in the same crevices as the latter; and third, in plates in the midst of crystalline ferriferous bitter-spar." These relations are no doubt very singular, and are thus explained by Dr. Sterry Hunt: the black matter, probably in the form of bitumen, was "first introduced into the fissures, which were subsequently filled with the ferruginous bitter-spar, whose deposition was contemporaneous with that of the gold," and whose decomposition no doubt yielded the ochreous oxide of iron.

In the March number of the 'Geological Magazine' is a paper by Mr. Rofe, giving some collateral evidence on the subject of escape of fire-damp, derived from observation of the escape of gases from wells (especially "blowing wells") during different conditions of atmospheric pressure. His conclusion "that coal proprietors should take especial notice of any considerable fall in the barometer, and at such times force an extra ventilation," &c., is perfectly sound, but already well known to managers of collieries. The real difficulty seems to be, how to suddenly augment in any considerable degree the quantity of pure air circulating in the mine.

There is also a paper on the Arenig and Llandeilo groups, by the late Mr. Wyatt Edgell, in which that very promising geologist has endeavoured to show that the Llandeilo Flags can be separated naturally into two groups, which he proposes to call "Upper Llandeilo" and "Lower Llandeilo" respectively, the Arenig group underlying the latter, and also containing a distinct fauna. Three other interesting papers we can merely mention: (1) "On the relative Ages of the Boulder-clays," by Mr. George Maw; (2) "On the Secondary Cycadean Fruits of Britain," by Mr. W. Carruthers; (3) "On Lower Silurian Fossils," by Mr. H. A. Nicholson.

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* For a résumé of facts and opinions on this subject, see Quart. Journ. Science, No. xiii., p. 116.

In the April number are six papers: Professor M'Coy records the occurrence of the genus *Squalodon* in the Tertiary deposits of Victoria, Australia, as being a further proof of the Miocene age of those beds; Mr. Carruthers describes an Aroideous Fruit (*Aroides Stutterdi*) from the Stonesfield slate; Mr. Powrie gives a description of the genus *Cheirolepis;* Mr. E. Ray Lancaster describes a new genus of Cephalaspidian Fishes (*Didymaspis*) from the Passage beds of Ledbury; Mr. J. Saunders gives some notes on the Geology of South Bedfordshire, made during examinations of the new cuttings on the Midland Railway; and the Rev. Mr. Gunn, in a paper on the Anglo-Belgian Basin, gives a theoretical sketch of the physical features of the country inhabited by the mammals whose remains are found in the Forest-bed of Norfolk.

In the May number is an important paper by the Rev. O. Fisher, "On the Ages of the 'Trail' and the 'Warp,'" in which the author enters into a discussion of the theories of M. Adhémar and Mr. Croll, which, coming from a mathematical geologist, will be appreciated by all who take an interest in the subject. He considers that the Palæolithic period was more ancient than the formation of the "trail," and formed "some part of the interval between 100,000 and 200,000 [years] before A.D. 1800." Then, after the Glacial era of the "trail," followed a period of equable seasons, of about 80,000 years' duration, "which would have been that of the submarine forests and their occupants." After this came the period of the "warp"—"a short period of severe winter cold;" and, finally, the period of the last submergence of our valleys had passed away about 8,000 years ago. The other papers in this number are "On a Cycadean Stem from Potton, Beds," by Mr. Carruthers; "On the May Hill Sandstone," by Mr. Salter; and "On Valley Terraces," by Col. Greenwood.

Amongst the correspondence we notice a continuance of the discussion on Hydrothermalism between Mr. David Forbes and Mr. James Geikie; and we are glad to find that the former has resolved the doubt which we expressed in our last Chronicle, by stating that "Notwithstanding my distinct statement *to the contrary,* Mr. James Geikie seems determined to make the object of my communication appear as a declaration against hythrothermal action."

PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

A large portion of the last number of the Society's Journal is taken up with the Annual Report and the Address of the President (Mr. W. W. Smyth). The former contains nothing specially worthy of notice; but the Address is a valuable resumé of modern opinions on questions of Chemical Geology, which the President's high reputation invests with exceptional importance. The origin of serpentine, for instance, is a question which has for many years occupied the attention of petrologists, and Mr. Smyth brings together the chief facts and arguments in support of the several theories which deserve consideration. Among those who demur to the igneous origin of serpentine, two principal views may be discerned. That held by the majority is that generally serpentine has been derived from a "decidedly crystalline unstratified rock, in which the constituents are augite, or hornblende, and a felspar; whilst a few investigators, chiefly, however, for a special region, term it an indigenous rock, as having been altered *in situ* from a sea-borne sediment." Mr. Smyth, like most petrologists, takes exception to Dr. Sterry Hunt's view that the silicated minerals in which the structure of *Eozoon* has been preserved "have been formed, not by subsequent metamorphism in deeply buried sediments, but by re-actions going on at the earth's surface." The President likewise discusses at some length M. Daubrée's memoir on Meteorites, especially with reference to the original condition of the earth, and contrasts the results of that author's experiments with the unsupported *dicta* of M. Friedrich Mohr in his work entitled 'Geschichte der Erde.'

The part devoted to the Proceedings of the Society commences with an important paper, by Professor Huxley, on a new specimen of *Telerpeton Elginense,* in which the author shows "that this animal is one of the Reptilia devoid of the slightest indication of affinity with the Amphibia." Professor Huxley further refers it to the sub-order Kionocrania of the true Lacertilia, which contains all the modern Lizards. This conclusion of course renders it more probable than ever that the age of the deposit in which it is found, associated with *Stagonolepis, Hyperodapedon,* &c., is Trias and not Old Red Sandstone; and we have recently learnt that further confirmation of the Mesozoic age of the strata has been obtained by the discovery of one of its associates in Warwickshire.

Mr. S. V. Wood, jun., in the next paper, describes a section at Litcham exhibiting contorted and broken layers of chalk and flint bands, as affording evidence of Land-glaciation during the earlier part of the Glacial period in England. This is followed by a paper, by Mr. F. W. Harmer, "On the Existence of a Third Boulder-clay in Norfolk," which he considers to be more recent than the true Boulder-clay, and even than the plateau-gravel of the district.

In an important paper "On the Age of the Lower Brick-earths of the Thames Valley," Mr. Boyd Dawkins grapples with a subject which has been a fertile source of discussion since the year 1836. These deposits were considered by Dr. Falconer to be anterior in age to the Boulder-clay, and by Mr. Prestwich to belong to the Low-level series of Quaternary deposits. The sections at Ilford, Grays Thurrock, Crayford, and Erith all show the following deposits in ascending order: (1) the fluviatile brick-earths and gravels, whence the Mollusca and Mammalia are derived, and which are remarkable for the horizontality of their bedding and the even sorting of their component parts; (2) the "trail" of Mr. Fisher, of a highly confused nature, and as remarkable for the contortion of its bedding as the deposits below are for their horizontality; (3) the surface-soil resting on the uneven summit of the preceding. These three deposits indicate three epochs: First, that of the brick-earths, in which the water was unencountered by floating ice; then that of the trail, which is probably a mere icewash formed under a glacial climate; and lastly, the rainwash, formed under temperate conditions. The presence of *Elephas priscus* and *Rhinoceros megarhinus* indicates the affinity of this group of deposits to those of Preglacial age on the Norfolk shore, and to the foreign Pliocenes. The tichorhine and leptorhine Rhinoceroses, on the other hand, point towards deposits of clearly defined Postglacial age. The preglacial Trogonthere, *Rhinoceros etruscus, Elephas meridionalis, Sorex moschatus,* and *Cervus dicranios* are absent on the one hand, the entire group of Postglacial Arctic Mammalia on the other; and especially among these latter the Reindeer. The Lower Brick-earths therefore afford remains in part peculiar to the forest-bed of Norfolk and the Pliocenes of France and Italy, and in part to the Postglacial deposits, and probably occupy a middle point in time between the two, being more modern than the former and more ancient than the latter. For these reasons the author suggests the following classified list of Pleistocene deposits: (1) Forest-bed of Norfolk—climate temperate; (2) Lower Brick-earths of the Thames Valley—climate temperate; (3) Glacial deposits—climate severe; (4) Postglacial deposits—climate severe, but gradually becoming temperate.

Mr. Maw's paper "On the Occurrence of Consolidated Blocks in the Drift of Suffolk" is a contribution to the evidence on the geological position of the blocks of saccharoid sandstone which are found scattered on the surface of many parts of the chalk-districts, and which appear to have been derived from several formations of different ages. In the author's opinion the blocks now treated of, many of them several tons in weight, were formed by the consolidation *in situ* of the loose drift in which they occur.

There is also a "Geological Description of the First Cataract, Upper Egypt," by Mr. J. C. Hawkshaw, which is worthy of study by those interested in the Geology of the Nile Valley.

9. MINERALOGY, MINING, AND METALLURGY.

MINERALOGY.

UNDER the name of *Ekmanite*, Herr Igelström describes[*] a new mineral from the iron mine of Brunsjö, in Grythyttan, Government of Örebro, Sweden. The mineral occurs in veins and bands, penetrating the magnetic ore which forms the object of exploration in the mine. Several analyses lead to the general formula:—

$$2\ (2\,RO,\ Si\,O_3) + 3\,HO,$$

where RO represents the protoxides of iron, manganese, and magnesia. The name has been given in honour of the well-known Swedish iron-master, Herr G. Ekman.

Early in 1865 a peculiar mineral, at that time regarded as a silver-ore, was discovered in the Blind Spring Mountains, Mono Co., California. It occurs in irregular deposits, associated with argentiferous galena, and presents the appearance of a compact lustreless substance, varying in colour from yellowish-green to black, and having a hardness of from 3 to 4, and a specific gravity of 3. Mr. Albert Arents, of Mono, has recently analyzed this supposed silver-ore, with the following results:—

Teroxide of antimony	47·65
Protoxide of copper	32·11
" " silver	6·12
" " lead	2·01
" " iron	2·33
Water	8·29
	98·51

From this analysis, the mineral is evidently an antimonite of various protoxide bases expressed by the following formula:—

$$3\ (Cu\,O,\ Ag\,O,\ Pb\,O,\ Fe\,O)\ Sb\,O_3 + 3\ HO.$$

The mineral is, therefore, a new species, for which Mr. Arents proposes the name *Partzite*, after its discoverer, Dr. Partz.

Some doubts have since arisen as to the propriety of regarding the mineral in question as a distinct species; but Mr. Arents has met the objections by showing that the observations on which they rest must have been made, not on the Partzite itself, but on the main body of the Blind Springs ore.*

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[*] Das neue Mineral Ekmanite. Berg-und Hüttenmännische Zeitung, 1867. No. 3, p. 21.

Few men have a better right to speak on the chemical origin of minerals and rocks than Dr. Sterry Hunt, of the Geological Survey of Canada. This indefatigable chemist has recently laid before the French Academy of Sciences his views "On the Formation of Gypsums and Dolomites."† Alluding to his former researches, Dr. Hunt shows that the reaction of a solution of bicarbonate of lime on sulphate of magnesia gives rise to the formation of sulphate of lime and bicarbonate of magnesia. It is, however, extremely difficult to obtain, on evaporation, a complete separation of the two salts produced by this double decomposition; for the bicarbonate of magnesia on exposure to the atmosphere loses a portion of its carbonic acid, and passes to the condition of a neutral or a sesqui-carbonate, which easily decomposes the sulphate of lime, reproducing carbonate of lime and sulphate of magnesia. To obviate this loss of carbonic acid, Dr. Hunt conducts the evaporation in an atmosphere highly charged with carbonic acid; such an atmosphere effectually preventing the decomposition of the bicarbonate, and allowing the gypsum to separate in a pure crystalline form. To apply these laboratory experiments to the explanation of the natural origin of gypseous and dolomitic rocks, the author has recourse to the opinion still entertained by some geologists, that the proportion of carbonic acid in the atmosphere must have been much greater in the earlier periods of the world's history than at the present time. This admitted, his experiments afford a simple explanation of the formation of beds of gypsum, and also of the magnesio-calcareous rocks with which they are commonly associated. The water of most natural springs holds in solution more or less bicarbonate of lime, which, when carried down to the sea, reacts on the sulphate of magnesia present in sea-water, producing sulphate of lime and bicarbonate of magnesia; and the water containing these mixed salts, on evaporation in a basin of limited area and under an atmosphere rich in carbonic acid, deposits the sulphate of lime in the form of gypsum, while the magnesian carbonate, uniting with carbonate of lime, may be precipitated as a dolomitic sediment.

At a subsequent meeting of the Academy, Dr. Hunt followed up the subject in a paper "On Certain Reactions of Magnesian Salts, and on Magnesia-bearing Rocks."‡

The same eminent chemist gives the result of much philosophical thought in a memoir "On the Objects and Method of

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* 'San Francisco Mining Press,' 1867, Jan. 19, Feb. 9, and April 13.

† "Sur la Formation des Gypses et des Dolomies:" 'Comptes Rendus,' 1867, No. 16, p. 815.

‡ "Sur quelques Réactions de Sels Magnésiens et sur les Roches magnésifères:" 'Comptes Rendus,' 1867, No. 17, p. 846.

Mineralogy," read before the American Academy of Sciences.[*] The author advocates the extension of mineralogical science, so as to embrace the entire range of inorganic substances whether occurring native, or produced by the chemist's skill; and then, passing to the great problem of classification, discusses the objects of a "natural system" and the basis upon which it must be founded. "Such a classification," says Dr. Hunt, "will be based upon a consideration of all the physical and chemical relations of bodies, and will enable us to see that the various properties of a species are not so many arbitrary signs, but the necessary result of its constitution." Not until this shall be accomplished, at least in a measure, can mineralogy expect to take equal rank with the kindred sciences of systematic botany and zoology.

Mr. T. Davies, of the British Museum, calls attention to the occurrence in Cornwall of the rare oxide of antimony called *Senarmontite.* The mineral occurs in opaque octohedral crystals lining a cavity in a specimen of Jamesonite from Endellion.[†]

Every mineralogist is familiar with the calcite-shaped crystals from the Fontainebleau sandstone. Somewhat similar groups of crystals have recently been found in a valley near Heidelberg, and have been described by Professor Blum.[‡] They occur in the centre of certain irregularly-shaped sandstone nodules, which have been weathered out from the Bunter Sandstone of the surrounding rocks. The crystals present the scalenohedral form of calcite, but consist entirely of sandstone. Professor Blum supposes that the calc-spar originally crystallized in the midst of loose sand, which afterwards concreted around the crystals, forming a solid mass; the enclosed calcite being subsequently removed by the percolation through the external sandstone of water holding carbonic acid in solution, and its place supplied by the deposition of silica, which had served as a cementing medium to the sandstone. Occasionally a cavity exists between the investing and the enclosed sandstone; but originally the sandstone must have closely covered the calcite, since it bears the sharp impression of its crystals; the space, therefore, between the kernel and its shell shows that the quantity of silica introduced was insufficient to entirely replace the carbonate of lime which had been removed.

Dr. How's "Contributions to the Mineralogy of Nova Scotia" are continued in the 'Philosophical Magazine' for May.[§] Several analyses are given of certain dark-coloured pebbles found at Cornwallis, King's Co.; and although the results show that the composition is by no means uniform, sufficient evidence is obtained to refer the mineral to the rare species *Wichtyne.* The Professor then describes three argillaceous rocks, apparently of local interest only; and, finally, notices the occurrence of bitumen on calcite in Inverness Co., Cape Breton.

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[*] 'Silliman's American Journal of Science and Arts,' March, 1867, p. 203.

[†] 'Geological Magazine,' April, 1867, p. 192.

[‡] Bunter Sandstein in Formen von Kalkspath. Leonhard's Jahrbuch, 1867. Heft III., p. 320.

[§] 'Phil. Mag.,' May, 1867, p. 336.

It is not a little remarkable that there should be on record but comparatively few analyses of so common a mineral as iron pyrites. M. Mène has, therefore, done good service by undertaking a complete chemical examination of the mineral, the results of which are published in a "Note on Yellow and White Iron Pyrites."* The value of this short memoir will be appreciated by remembering the amount of labour represented by the thirty-six original analyses which it contains. The author calls attention to the fact, brought out by these researches, that the ordinary yellow cubic pyrites contains much less water than does marcasite, or white rhombic pyrites; and that the difference in the stability of the two species on exposure to atmospheric influences may be referable to the varying amount of argillaceous impurities present.

Some time back, Mr. J. P. Cooke, jun., described a new American mineral, called Danalite, occurring in the granite of Cape Ann, Massachusetts. Associated with this are two remarkable micas, one of which is a variety of Lepidomelane, while the other appears to be a new species, which, from its easy fusibility and its foliated structure, has received the name of *Cryophyllite.*† This mineral, like the other micas, crystallizes in six-sided prisms belonging to the rhombic system, and has a perfect basal cleavage. The crystals are optically biaxial, and are dichroic, presenting a dull-green colour when viewed in the direction of the principal axis, and a reddish brown when examined transversely. The spec. grav. is 2·909, and the hardness varies from 2 to 2·5. The large amount of alkalies present, amounting to 13·15 per cent. of potash and 4·06 of lithia, seems sufficient to account for the extreme fusibility of the mineral.

The composition of *Boronatrocalcite* or *Natroborocalcite* has recently been the subject of some discussion.‡ There seems good chemical reason for accepting the formula which Dr. Lunge has established from his carefully conducted analyses, and which may be thus expressed:—

$$2\,(\mathrm{Na\,O},\ 2\,\mathrm{BO_3}) + 5\,(\mathrm{Ca\,O},\ 2\,\mathrm{BO_3}) + 42\,\mathrm{HO}.$$

For some time past, Professor Graham has been engaged in a series of researches on the absorption of gases by metals; and, quite recently, these investigations have, in a most unexpected manner, yielded results which promise to throw considerable light on the origin of meteorites. His experiments have shown that many metals, when heated in certain gaseous media, are capable of absorbing a large volume of the gas which may be retained at ordinary temperatures, for an indefinite period, condensed within the interstices of the metal, but ready to be evolved at any moment by a sufficient elevation of temperature; this power being denoted by the term "occlusion." Pure iron, for example, heated to low redness in carbonic oxide, occludes upwards of four times its volume of the gas; and hence a piece of ordinary wrought iron heated *in vacuo* yields a considerable amount of carbonic oxide derived from the atmosphere of the furnace in which it was prepared. It became, therefore, a matter of much interest to determine whether meteoric iron contained any, and if any, what kind of occluded gas; and experiments were accordingly made with the Lenarto meteorite. When a carefully cleaned piece of this iron is heated in a tube connected with the exhausting apparatus known as "Sprengel's pump," it yields 2·85 times its volume of gas, having the following composition:—

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* "Note sur les Pyrites de Fer jaunes et blanches:" 'Comptes Rendus,' 1867, No. 17, p. 867.

† "On Cryophyllite, a new mineral species of the Mica family:" 'Silliman's American Journal,' March, 1867, p. 217.

‡ See 'Annalen der Chemie und Pharmacie.' Bd. cxxxviii., p. 51; cxxxix., p. 52; cxli., p. 379; and 'Chemical News,' 1867, Feb. 22nd; April 9th; and April 26th.

Hydrogen	85·68
Carbonic oxide	4·46
Nitrogen	9·86
	100·00

Now since the occluded gas is in every case a remnant of the atmosphere in which the metal was last ignited, the conclusion seems almost inevitable that the meteorite in question must have been intensely heated, before reaching our earth, in a dense atmosphere highly charged with hydrogen,—a conclusion which receives additional interest when studied in connection with Messrs. Huggins and Miller's researches on the stellar spectra, and with the Father Secchi's recent attempt to classify the fixed stars according to their spectra, hydrogen being the characteristic element in those of which *α* Lyræ is the type. The discovery has been communicated to the Royal Society by the Master of the Mint, and has been brought before the audience of the Royal Institution by Dr. Odling.

M. Dumas has called the attention of the Academy of Sciences of France to a peculiar substance, the origin of which is unknown, which possesses the general character of anthracite, but approaches the diamond in hardness. Attention has been especially directed to this, hoping that the source from which it has been derived may be discovered, and the peculiarities further examined.

Dr. Schrauf, of the Imperial Museum of Vienna, has communicated to the Academy* the correction of the weight of the great

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* Sitzungsb. d. k. Ac. d. Wiss., Bd. LIV., p. 5.

Austrian diamond called "Florentine," which has been made by the commission appointed to examine it.

According to the Imperial inventory, the stone weighs 133⅛ carats, whilst in all works on precious stones the weight is given as 139½ carats. The recent examination of the gem shows its specific gravity at 19° Cent. to be 3·5213, and its weight, 27·454 grammes. Now the value of the carat is:—

In Amsterdam . . .	205·7000	milligrammes
„ Florence	197·2000	„
„ Paris	205·5000	„
„ Vienna	206·1300	„

Therefore the newly-determined weight, 27·454 grammes, corresponds to 139¼ Florentine carats, 133⅝ Paris carats, and 133·180 Vienna carats. The last number, corrected for weighing in air, gives 133·160 Vienna carats as the true weight of the famous Florentine.

MINING.

The Select Committee on Mines continues its sittings. Several of the Colliery Inspectors have been examined. It is evident from the tenour of nearly all the questions that the members of this Committee are inclined to recommend an additional number of Inspectors, and possibly the introduction of sub-Inspectors.

There is a great objection to the latter; an inferior class of men would be placed in positions of considerable responsibility, and they would not be enabled to exert any beneficial influence over the men. Any attempt to remove the responsibility from the coal owner and his agents will be replete with danger.

Another Committee deals with the question of Mines Assessment, admitting in the abstract, the correctness of the principle of rating mines to the poor; it is unfortunate that any additional burden should now be thrown upon our mineral industries. A very mistaken idea prevails, arising mainly from the want of practical acquaintance with the subject; many persons conceiving that since the mines draw a population to a parish, and thus in the course of time throw many burdens on it, that justice demands from them their contributions towards the support of that poor. The result at this time, if the Bill introduced by Mr. Percy Wyndham should become an Act, would be that a large number of mines which are now working at a considerable monthly loss, and which are continued hoping for an improvement in the metal market, for the purpose of keeping the miners employed—as if once dispersed they would never again be gathered together—would be abandoned, and thus hundreds of families thrown heavy burdens on the parishes. Under more favourable aspects there would be but little objection on the part of the mine proprietors to an equitable system of rating.

The Committee at their last meeting carried the following resolution by a majority of 7 to 4:—

"Provided always that after the passing of this act no occupier of any mine within the jurisdiction of the Stannary Courts of Devon and Cornwall, or of the High Peak Mining Customs and Mineral Courts Act (14 and 15 Vic, c. 94), and the Derbyshire Mining Customs and Mineral Courts Act (15 and 16 Vic. c. 163), shall be liable to be rated to the relief of the poor, to the county and highway, and other local rates, and no assessment shall be made on such mines, otherwise than on the owner or owners in respect of the rent, royalty, toll, or due reserved to him or them."

It now remains to be seen whether the House of Commons will accept the amended bill.

The present condition of the Tin and Copper Mines of this country will be best understood by the following statement of facts.

In 1860, 405 mines paid dues upon the ores raised to the Stannary Court. In 1866, they were reduced to 315. The value of all the ores upon which those dues were paid was in 1861 2,068,123*l.*; whereas in 1866 it was only 1,404,462*l.* In 1861, the number of Cornish and Devonshire Mines paying dividends amounted to fifty-eight; but in 1866 there were but twenty-six mines which paid dividends. With two or three exceptions the dividends were small, and in some of the mines it was deemed prudent to pay the dividend out of the reserved funds, as widows and orphans were entirely dependent on them for their subsistence. Within the last eighteen months about 11,500 persons have been thrown out of employ; and of these above 7,000 have left the Western counties. Six thousand have emigrated to America, to Australia, and New Zealand; the others having found employment in the collieries of Scotland, and a few on the lines of railway now in process of construction.

Safety Lamps have been made the subjects of a series of most carefully contrived experiments by some of the colliery engineers of the Newcastle district, and the result has been to show that none of the lamps at present in use, under the circumstances to which they are exposed in *well-ventilated* collieries, are *safe*. The experiments were made after the following manner. The safety lamp under trial was placed in a wooden pipe, through which any mixture of gases and atmospheric air could be driven at any velocity, the rate being measured by Dickinson's or Biram's anemometer. It was found when an explosive mixture of carburetted hydrogen and atmospheric air—fire-damp—was made to travel the pipe at a velocity of 8 feet per second, the ordinary Davy Lamp began to heat, and in a few moments it exploded *out-*

side. It appears that the "Georgie"—that is Stephenson's lamp—and Clanney's, were not found to be any safer than the Davy; and the Belgian lamps Eloin's and Mueseler's were equally liable, under certain conditions, to explosion. A few years since those lamps were what they professed to be—with the currents of air travelling at the rates which were then common, there was nothing to be apprehended. Ventilation has been greatly improved, and the quantity of air now driven through a colliery is nearly double that which was considered necessary a few years since. Consequently a lamp is now exposed, especially in our best collieries, to a current having twice the velocity of the air to which it was formerly exposed. This improved rate of ventilation renders, according to the experiments at the Hetton colliery, all existing safety lamps dangerous whenever an atmosphere of fire-damp prevails. These experiments must be repeated under all conditions; and the safety lamps, which are evidently correct in principle, must be modified to meet the improved conditions of ventilation.

Such paragraphs as the following are from time to time appearing in the newspapers relative to the extension of our coal-fields.

"The question as to whether coal may not be found under other formations than those acknowledged and defined, is having a practical solution in the extreme south of Derbyshire, at a point where it *has been laid down on the geological map as being free from anything of the kind.*" We are then told that at Coton Park, a few miles from Gresley, a wealthy proprietary are sinking in the expectation of reaching coal at a moderate depth; and the writer continues—"Should they be successful, of which there is a strong probability, the finding of the coal cannot but have an important bearing on the important question which the Royal Commission is now investigating as to the extent of our coal-fields."

If the writer of this had been at the trouble to consult the published evidence of the Geological Survey in regard to this very district, he would have found, upon Horizontal Section, No. 52, a well-defined plan of the strata and of the faults by which it has been disturbed, with the following remark—"*The coal-measures of this area have not been proved, but the coal seams probably rise towards the west under the New Red Sandstones, and in any case their depths are influenced by the faults here marked.*" This certainly does not confirm the writer's statement as given above, but it proves that the existence of coal over this area is well known, though the depth at which it will be found has yet to be determined.

A mine of Antimony of St. Mary-le-Plain, in the canton of Massiac, in the department of Cantal, Central France, which was worked with some activity in 1860, and abandoned in 1865, has just been reopened, and workings are commenced with the promise of a thorough examination, and it is hoped of a satisfactory result. This mine is stated to produce native antimony, sulphide of antimony, or glance antimony, and the grey and red ores of this metal.

Mr. J. G. Williams, of Aberystwith, who has for many years been connected with the Lead mines of Cardiganshire, especially those which are in the Gogerdan property, has just published an interesting little work, called 'A short Account of the British Encampments lying between the Rivers Rheidol and Llyfnant, in the county of Cardigan, and their connection with the Mines.' Mr. Williams has instituted a careful examination of a considerable number of ancient encampments He finds some to be, as he considers, peculiarly British, others being Roman, or Roman-British; and their positions prove unmistakably that they were constructed for the purpose of protecting the mines adjoining them. Wherever there is a group of mines, Mr. Williams finds a group of encampments also. This is really a valuable contribution to the obscure history of early British Mining.

In connection with publications relating to Mining, we may state that we have seen the advanced sheets of a work 'On Gold and Silver Mining and Metallurgy in all parts of the World.' It is by Mr. John Arthur Phillips, a gentleman well known as the author of a 'Manual of Metallurgy,' and for his extensive acquaintance with the Mines of the Old and the New Worlds. The book is extensively and beautifully illustrated.

Dr. Clement Le Neve Foster, D. Sc., Lecturer to the Miners' Association of Devon and Cornwall, has translated from the Dutch Van Diest's 'Banca, and its Tin Stream Works,' which is decidedly the best account of this extraordinary stanniferous district which has appeared. It cannot but be of the greatest importance to the English Tin miners to know exactly the conditions under which the Dutch obtain the tin in their Eastern possessions. The Banca Tin being at the present time the most serious rival with which the British Tin miner has to contend.

Professor F. de Hochstetter has recently brought before the Imperial Geological Institute of Vienna an account of several "exploitations" for coal and iron in the Banat. The coal formation of Steierdorff, which was discovered in 1790, and which belongs to the Lias formations, has within the last few years been brought into notice. Five beds of coal have been worked upon, and they give a yearly production of 165,000 statute tons. This coal is known commercially as the coal of Orawieza, and is one of the best produced in the Austrian Empire as regards calorific power. Much of it is used for the steam navigation of the Danube, and for locomotive purposes on some of the railways. Gas is manufactured from it at Pesth and Temesvar, and in many of the great industrial establishments of Hungary.

In connection with these coal beds considerable deposits of argillaceous iron ores are found, and overlying them beds of bituminous shales which are very rich in mineral oil, which is used, under the direction of Dr. O. Gomelin, in the manufacture of paraffine and photogene.

Professor Hochstetter remarks that the coal of this district competes, and not without success, with the British coal which finds its way to the Danubian Provinces. Sulphides of iron, lead, and zinc, are stated to be associated with the iron ores.

The demand for coal in France is rapidly increasing, and consequently we find an increase in the quantities of coal sent into that country from England and from Belgium. The quantities sent from the two countries being as follows:—

		Tons		Tons.
1864	Belgian	3.150,185	English	1,285,514
1865	"	3,350,782	"	1,562,627
1866	"	3,785,711	"	1,904,091

The French Government, anxious to preserve the existing woods in France, are doing all they can to induce English coal-owners to send coal into that country, and the great railway companies have agents in England, making special inquiries as to the probable quantities of coal which may be sent into the interior of France if the railway rates are reduced.

It has been, not unfrequently, said, and very generally believed, that the Gold Mining of Australia was rapidly declining. The last number of Dicker's 'Mining Record,' an admirable weekly paper, published in Melbourne, and devoted to the consideration of the important mining interests of Victoria, gives in its share circular, the names of thirty-eight dividend alluvial mines and of thirty-six progressive alluvial mines; of sixty dividend quartz mines and of sixteen progressive quartz mines. This does not look like a failing of activity in gold washing or mining. Within sixteen years the two colonies of Victoria and New South Wales have produced a supply of gold amounting in value to 150,000,000*l.* sterling, four-sixths of which has been the produce of Victoria alone.*

We have just seen some very interesting specimens of Gold sent home from Otago, New Zealand, by Mr. William Warren, and some gems, topazes, amethysts, sapphires, rubies, rock crystal, and a remarkable siliceous gem of extreme hardness, which we believe to be new. We note this to show the importance of carefully examining the residues of the gold washings of this colony. The gems now sent are small and not of much value, but they indicate the high probability of finding such as would be of real value.

* See also article on "The Progress of Science Abroad," in the present number. 'Intercolonial Exhibition, 1866. Mineral and Mining Statistics.'

Welsh Gold Mining, which a few years since was of great promise, has almost entirely failed to be remunerative; but two mines produced any quantity of gold in 1866, Vigra and Clogan being one, and Castell Carn Dochan the other, and from the Quartz lodes of these mines about 1,200 ounces of gold were obtained.

METALLURGY.

There has been for some time an evident want of activity in our Metallurgical processes. The causes of this are sufficiently obvious. The unfortunate attitude assumed by the workmen—more unfortunate for their future than for the future of masters—and the general disturbance of trade being the principal ones. Resulting from this, we find but few of our great manufacturers exhibiting at Paris; but beyond the influence of trade depression, there is another influence yet more potent, which has prevented the display of the finer specimens of English manufacture. Exhibitions have not, as a rule, been found profitable. The regular system of the workshops has to be disturbed, and much inconvenience suffered, which the resulting advantages have not been found to balance. It is therefore most fallacious on the part of Dr. Lyon Playfair to assume that English manufacture is retrograding, because the display of our metallic industries at Paris is an imperfect one. A glance at the Catalogue will convince any one that our highest-class manufacturers have not exhibited. Yet Dr. Playfair, writing to Lord Taunton, thus expresses himself:—"I am sorry to say that with very few exceptions, a singular accordance of opinion prevailed that our country had shown little inventiveness, and made but little progress in the peaceful arts of industry since 1862. Deficient representation in some of the industries might have accounted for this judgment against us, but when we find that out of ninety classes, there are scarcely a dozen in which pre-eminence is unhesitatingly awarded to us, this plea must be abandoned. My own opinion is worthy only of the confidence which might be supposed to attach to my knowledge of the chemical arts; but when I found some of our chief mechanical and civil engineers lamenting the want of progress in their industries, and pointing to the wonderful advances which other nations are making, when I found our chemical and even textile manufacturers uttering similar complaints, I naturally devoted attention to elicit their views as to the causes."

It is not necessary to quote any further from Dr. Lyon Playfair's letter, which proceeds to inform Lord Taunton that the one great want of England is technical schools.

Dr. Playfair is exceedingly illogical. In the first place, his complaint is that "our country had shown little inventiveness since 1862;" and then he speaks of the "wonderful advances which other nations are making." We must ask him, In what do those wonderful advances consist? Certainly not in inventiveness. For notwithstanding the want of activity in English manufacture and trade, we are so bold as to state that there has been more inventiveness shown in England since 1862 than in all the nations of Europe put together. If the "wonderful advances" refer to manipulatory details, we believe, in many cases—certainly not in all—Dr. Lyon Playfair will be right enough. But the absolute weakness of this letter, put forward with an air of authority which is not pleasant, consists in taking what is confessedly an imperfect display of British industry, as a fair example of the present power of the British workshops. In concluding his letter, Dr. Playfair says, "It would be important that the Government either through your Commission or through the Committee of Council on Education, should hold an official inquiry on this subject, and should tell the people of England authoritatively what are the means by which the great States are attaining an intellectual pre-eminence among the industrial classes, and how they are making this to bear on the rapid progress of their national industries."

In our Mineral and Metallurgical Industries to which especial reference is made, and to which we desire to confine ourselves, there is not, in the first place, that want of inventiveness which Dr. Lyon Playfair supposes; and in the second place, supposing it did exist, it would not be remedied by any authoritative telling of a Royal Commission or a Committee of Council.

Our iron furnaces are improving in construction and increasing in size. The iron made from inferior ores is greatly improving in quality. Our mills are now the finest in the world, and capable of executing any work for which there may be a demand. We are the only people in the world who are striving—and striving too with every prospect of success—to carry out the process of puddling by machinery; and where else shall we find coal cutting by machinery in so advanced a state as in the British coal fields?

In our processes of Lead Smelting great advances are being made—and from ores of lead containing copper, the best lead can now be manufactured. Indeed, in each of our metallurgical processes we can point to improvements which will show how exceedingly imperfect is the knowledge possessed by Dr. Lyon Playfair; and a little consideration would have prevented Earl Granville from basing his remarks,—made at the distribution of prizes at the London University,—on so fallacious a letter as that addressed to Lord Taunton.

An alloy of Platinum and Steel has been formed which possesses some peculiar properties. When these two metals are in a state of fusion, they alloy in all the proportions tried. This alloy takes a fine polish, does not tarnish, and its pure colour peculiarly fits it for a mirror. Its density is 9,862. If two pieces, one of steel and the other the alloy of steel and platinum, be plunged into dilute sulphuric acid, the alloy is attacked with violence, while the steel remains untarnished. This alloy is thus attacked by acids in all proportions, until ninety parts of platinum with twenty of steel are united.*

Alloys of Silver and Steel were made long since by Stodart and Faraday, and then fully examined; our French friends have recently announced an examination of these argentiferous alloys as something new.

The Iron Sand of New Zealand is again attracting attention, and a company has been formed for working it. Let us hope that the experiment of making pig iron from this ore may be practically more successful than the former attempts to do the same thing has been.

M. Julien has presented to the Society of Encouragement of Paris a pamphlet on Iron and Steel, in which he puts forth some peculiar views on the combination, or rather mixture, of carbon and iron. The cleverness of this essay and its novel views will commend it to the attention of the man of science and to the steel manufacturer.

The manufacture of Steel Iron from Cinder Pigs, which has been for some time the subject of experiment, appears to be now nearly approaching a successful development. Mr. Heaton, of Langley Mills, places nitrate of soda at the bottom of the crucible and covers it with a perforated iron plate. The iron to be purified is placed above this, and the melted nitrate of soda diffuses itself through the melted metal, producing, according to the statement of the inventor, complete desulphurization and dephosphorization.

A number of experiments were made recently at Langley Mills with cinder iron, which would have been utterly useless in the Bessemer converters. The result is stated to have been the production of steel iron of the finest quality.

We understand that a large Staffordshire firm is preparing to make the experiment upon a large scale; we shall anxiously watch and report the result obtained.

10. PHYSICS.

LIGHT.—Mr. Sorby, in this Journal, two years ago, described his application of Spectrum Analysis to microscopical investigations, and especially to the detection of blood stains. Mr. Browning has recently made for Mr. Sorby a modification of the spectroscope, which is intended to slip into the eye-end of a microscope, instead of the eye-piece.

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* 'Les Mondes,' tome xiii., 15 livraison.

The instrument contains a series of prisms arranged for viewing the spectrum by direct vision, and there is an arrangement for the purpose of obtaining a supplementary spectrum from any object whose spectrum it is desired to compare with that of the object placed on the stage of the microscope; which object may be either a solution of permanganate of potash in a small sealed tube, a cobalt-blue glass, or anything else which will furnish a standard spectrum for comparison. Milled heads with screw motions enable the observer to adjust the focus of the different parts of the spectrum and to open and shut the slit vertically and horizontally. Powers of from half-an-inch to 1-20th may be employed, and by using a binocular microscope the object may be brought into the field and examined in the ordinary way through one tube, whilst its spectrum may be observed and compared with that of a standard light by means of the other tube. The object may be illuminated either by transmitted or reflected light, and any of the ordinary accessories may be used for this purpose, such as achromatic condenser, side reflector, Lieberkuhn, &c. Mr. Sorby proposes the use of a standard interference spectrum, to be used as a scale in all descriptions of spectra, as seen by the spectrum microscope. The scale is produced by a plate of quartz ·043-inch thick, cut parallel to the principal axis of the crystal, and placed between two Nicol's prisms. By this means the whole visible space is divided by dark bands into twelve regular divisions, having in all parts the same relation to the physical properties of light. These are counted from the red end towards the blue, their centres being reckoned as 1, 2, 3, &c., and the thickness of the plate is so adjusted that the sodium line exactly corresponds to 3½. The intensity of the absorption is expressed by the following types:—

Not at all shaded		(blank space)
Very slightly shaded	. . .	(dots with wide spaces)
Decidedly shaded	. . .	(dots closer together)
More shaded	...	(very close dots)
Strongly shaded, but so that a trace of colour is still seen	---	(three hyphens close)
Still darker	—	(single dash)
Nearly black	——	(double dash)

Except when specially requisite, only the symbols . . ., ---, —, are employed for the sake of simplicity, and then as signs of the relative rather than of the absolute amount of absorption, and it is assumed that there is a gradual shading-off from one tint to the other, unless the contrary is expressed. This is done by means of a small vertical line over the figure, which shows that there is a well-marked division between them. Definite narrow absorption-bands are indicated by * printed over their centre. In Mr. Sorby's paper examples are given which show how simple or more complicated spectra may readily be printed and compared. For instance, the spectrum of normal chlorophyll dissolved in alcohol (deep green), is represented by:—

$$\tfrac{7}{8}\;\overset{*}{\text{—}}\;2\tfrac{3}{8}\;\text{- - -}\;3\tfrac{1}{4}\;\ldots\ldots\;\overset{|}{4\tfrac{1}{2}}\quad 6\tfrac{3}{4}\;\text{- - -}\;7\tfrac{1}{2}\;\text{—}$$

and the spectrum of the same body, as decomposed by acids, as found in some leaves (olive green), by:—

$$1\;\overset{*}{\text{—}}\;2\tfrac{1}{8}\quad 2\tfrac{3}{4}\;\overset{*}{\text{- - -}}\;3\tfrac{3}{8}\quad 4\tfrac{1}{4}\ldots 5\tfrac{1}{4}\;\overset{*}{\text{- - -}}\;5\tfrac{3}{4}\ldots 6\tfrac{3}{8}\;\overset{*}{\text{- - -}}\;7\tfrac{3}{8}\quad 8\tfrac{1}{2}\;.\text{- -}\;9\tfrac{1}{2}\text{—}$$

The instruments and methods were exhibited and explained by Mr. Sorby and Mr. Browning at the last soirée of the Royal Society, where they excited the greatest interest.

The Rev. Father Secchi has continued his researches on the spectra of several classes of stars. He explains by the differences of temperature, or by the effect of absorption, the variation in intensity of certain lines—the hydrogen line F, for example.

The electric light has recently been fitted up on board the 'Prince Jerome,' the yacht of H.I.H. the Prince Napoleon; and several interesting experiments are to be tried with it. It is not proposed to illuminate the vessel itself, but, on the contrary, to light up other objects, such as a coast or a vessel for the object of attack or defence; ships at full speed or in station can thus be kept free of all danger of collision, and, in action, the object to be hit can be illuminated. The lamp is that known as Duboscq's, which has the advantage of not only having a regular movement when in a vertical position, but also burning with the same precision inclined at any angle, so as to be independent of the pitching or rolling of the vessel at sea. An apparatus is placed behind the lamp, which, hiding the light from the deck of the vessel, projects it in parallel rays on a given spot. Once proved to be useful on board a vessel, the electric light will soon be considered a necessary adjunct to the marine and transport service. The employment of the same light for railways, in the stations and approaches, tunnels, curves, &c., has been actively experimented on in France for some time past.

The question has again been raised of substituting the magneto-electric current for that of the battery in electrotyping, electroplating, and gilding. The magneto-electric machine of Mr. Wilde has been employed in the well-known establishment of Messrs. Elkington, and in Paris M. Christophe and M. Bouillet have resolved to make use of electricity engendered mechanically. They made a first trial at the works of the Alliance Company, and they have ordered two machines of four discs. In the establishment of M. Lenoir, 88, Rue Popincourt, a machine of this kind has been fitted up, which promises great success. The current is said to be able to deposit a pound of copper per hour.

Mr. Mellor, manager of the Magnesium Metal Company, has been experimenting on the alloys of Thallium and Magnesium, with the object of seeing whether, if such an alloy could be easily made into wire, it might be found to burn readily and to produce an intense bright green flame, when, from the portability of the wire, it would be well adapted to some of the purposes for which a green flame is required. It was found that thallium alloys most readily with magnesium, and in any proportions. The alloys are very stable, and are easily worked up into wire and ribbon. Alloys containing 5, 10, 15, 20, 25, and 50 per cent. of thallium were prepared; these all burn brightly and steadily, but the flame is smaller and the combustion slower than that of pure magnesium. The heat-conducting property of the alloy compared with magnesium is sensibly diminished, showing the change in the molecular construction of the metal. The smoke produced in the combustion of these alloys is more dense, and as it curls gracefully away it is seen to be fringed with a rather pretty dark-purple tint; but the magnesium light is so very intense, that it almost completely masks the thallium flame, so that it is not observable in some of the alloys—indeed, the green light is scarcely recognizable even in an alloy containing 50 per cent. of thallium.

As a concluding paragraph to our Chronicles of Optics we give a very excellent method of cleaning glass, which may be useful where other methods fail. It is taken from the Appendix of the second edition of Major Russell's 'Tannin Progress,' published by Robert Hardwicke, Piccadilly. Dilute the ordinary hydrofluoric acid, sold in gutta-percha bottles, with four or five parts of water; drop it on a cotton rubber (not on the glass), and rub well over; afterwards washing till the acid is removed. The action is the same as that of sulphuric acid when used for cleaning copper; a little of the glass is dissolved off, and a fresh surface exposed. The solution of the acid in water does not leave a dead surface on the glass as the vapour would; if a strong solution is left on long enough to produce a visible depression, the part affected will be quite bright. This method is recommended in some cases for cleaning photographic plates; but we should think it might also be useful in cleaning the insides of bottles, flasks, &c., which have got stained through use.

Heat.—M. Fizeau has been examining the abnormal contraction and dilatation of iodide of silver under the influence of heat. He finds that in this salt, whether in its amorphous or crystalline state, the action of heat is reversed; its dilatation being negative, contracting instead of expanding on the increase of temperature. But this negative dilatation is not quite the same in the amorphous state, in the state of compressed precipitate, as in the crystalline state. Raised to a temperature of 40° C. the co-efficient is, – 0·00000137 in the first case, – 0·00000139 in the second. This co-efficient is, besides, variable with the temperature and the direction in the interior of the crystal. In the direction in which the contraction is greatest, parallel to the axis, it is the $\frac{1}{1000}$ part for 100°, about a tenth of the dilatation of mercury. To see if this is an exceptional case, he has experimented upon other series of analogous salts such as the chlorides, bromides, and iodides. But he finds that whilst the co-efficient of dilatation of all the chlorides, bromides, and iodides is positive, as it is in the case of other substances experimented upon, as far as he has hitherto found out, the co-efficient of dilatation of the iodide of silver is alone negative.

V. Regnault has determined the specific heat of several specimens of natural and artificial graphite. Graphite from Canada, No. 1, gave a mean number ·19866; from Canada, No. 2, mean ·20198; from Canada, No. 3, mean ·19113; from Siberia, mean ·19879. Graphite from gas retorts, after being heated white hot, gave mean ·1968; the same kind of graphite, after being heated in a current of chlorine, gave ·2000, and that from Canada, No. 3, after like treatment, gave ·1977. Hard burnt clay gave ·1940; therefore the ash in graphite (consisting principally of clay) has no appreciable effect on the results obtained. H. Kopp remarks on the above numbers, that they are obtained by immersing the graphite heated up to 100° in the water of the calorimeter; that graphite is porous; therefore the heat given off by the water as it enters the pores of the substance reappears in the final result of the experiment. Regnault's numbers are higher than those obtained by Kopp.

The behaviour of some minerals at a high temperature has been studied by Dr. Elsner. He has heated a great variety of minerals and other rock constituents in a porcelain furnace to an estimated temperature of 2,500° to 3,000°, and finds in general that silicates containing the alkaline metals, or iron, are much more fusible than those which contain much alumina, or no iron; with the exception of obsidian, all the rocks experimented upon, even those of volcanic origin, presented after heating totally different characteristics from those which accompany them in nature; the crystalline varieties became compact and semi-fused; therefore he says they must have been produced in nature under different conditions from those of his experiments The conversion of pumice into an obsidian-like body is especially interesting. After heating, the rocks experimented on showed lower specific gravities.

Mr. H. Debray has communicated to the French Academy the results of some experiments having for their object to demonstrate that chemical decomposition is analogous to the evaporation of a liquid, in the sense that the tension of the gas proceeding from the decomposition is constant. He operated upon pure carbonate of lime, Iceland spar, or ordinary impure carbonate of lime, placed in the middle of a tube, communicating sometimes with a mercurial pump and sometimes with a gauge apparatus for measuring the tension of the carbonic acid disengaged by the decomposition. The carbonate was alternately submitted to four constant temperatures; *viz.* 360° C. (vapour of mercury), 440° (vapour of sulphur), 660° (vapour of cadmium), 1040° (vapour of zinc). It was found that at 360° the tension of the vapour of the carbonic acid was absolutely *nil;* at 440° it was hardly sensible; at 660° it was only 85 millimetres; at 1040° it attained 551 millimetres.

A remarkable discovery has been made by M. Peligot, from which it would almost seem as if the old tradition of the existence of malleable glass was not quite so absurd after all. A piece of St. Gobain glass, prepared a long time ago by M. Pelouze, had lost its transparency owing to devitrification, but had not altered in density. The piece of glass, supported by one extremity, was placed in a drawer, when it was found, after some days, to have become curved under its own weight, it having become in fact *malleable glass;* the surface at the same time being covered with efflorescence. Pliny speaks in his history of a glass that could be bent and unbent; and the story goes that Richelieu ordered an inventor to be put to death for proposing to divulge a process for making malleable glass.

The following very important conclusions have been arrived at by Messrs. Bussy and Buignet in their memoir on the changes of temperature produced by the mixture of liquids of different natures. 1. In all the cases under examination, with one sole exception, the calorific capacity of the mixture is a little superior to the mean capacity of the elements. 2. The liquids for which the increase of bulk is the most considerable are exactly those which develop most heat at the moment of their union, such as ether and chloroform, alcohol and water, sulphuric acid and water. The only instance hitherto noticed of a diminution of bulk is in the case of the mixture of *chloroform* and *bi-sulphide of carbon,* whilst at the same time decrease of temperature takes place at the moment of the union. 3. Independently of the loss of heat resulting from the changes of volume, there exists a cause which produces an absorption of heat, which can be sometimes equal and even superior to the heat given out by the combination of the liquids. This cause is not quite clearly made out. It is suspected to be related to the phenomenon of diffusion.

The following results have been obtained by M. Becquerel in some researches on the variations of temperature of the ground at different depths, made by the aid of the electric thermometer. At 1 metre beneath the surface of the ground the mean temperature varies between winter and summer as in the air. The difference between the maximum and the minimum is 6° C. in the ground, and 18·17° in the air. At 6 metres deep the variations occur in the inverse order, the maximum taking place in winter, and the difference between the maximum and the minimum being 1°. At 11 metres deep the variation is not more than 0·3°; the maximum takes place in winter, the minimum between the spring and summer. From 16 to 26 metres the variations follow the same law as in the air, with this difference, that the difference between the maximum and the minimum is only 0·27° C. This anomaly or inversion of the law is due to the infiltration of water through permeable strata. Between 26 and 31 metres the variations follow the laws the opposite to those of the air. Below 31 metres the variations of temperature attain scarcely 0·12°, the temperature being sensibly constant.

General Morin has described an electro-thermometric register for marking automatically, every quarter of an hour, the variations of temperature in an enclosed spot or in the open air. Some excellent forms of apparatus have already been invented and put to use for registering the variations of temperature, not only intermittently, but continuously.

A very ingenious as well as commercially valuable form of caloric engine has been lately exhibited in London. In principle it is based upon the fact, long known to scientific engineers, that the most economical mode of obtaining power from heat is by its direct application to the expansion of air, or other permament gases, rather than by that of steam or any other vapour. The hot-air engine now described differs, however, from the usual form of caloric engine in several essential particulars as to its construction, so that it is free from those defects which have hitherto prevented the practical carrying out of the caloric theory. In this engine the motive power, instead of being derived from the expansion of air heated in a separate generator as in former engines, is produced by the expansion of air heated by contact with the fuel itself; and in addition to this source of the power, by the action of the expansive force of the gaseous products of the combustion of the fuel, which heretofore have been permitted to escape into the chimney without being in any way utilized in the production of power. This result is accomplished by placing the fuel in a grate which can be hermetically closed, and forcing into it the air required for combustion by means of an air-pump worked by the engine itself, so that no part of the heated air or the gases produced by the combustion of the fuel can escape without passing through the cylinder, and there doing duty in the production of force. It is obvious that by such an arrangement the employment of separate iron generators for the purpose of heating the air is dispensed with, and that thereby one of the chief difficulties of the old caloric engine is avoided; for in the hot-air engine the fuel is contained in a fire-clay furnace surrounded by an air-tight iron casing, which in this way is entirely protected from injury. The fuel, which may be anthracite, smokeless coal, or coke, is thus burned under pressure with great regularity and with the production of a uniform temperature, and at a rate exactly proportionate to the duty the engine is called upon to perform, thus avoiding all waste of fuel—a result which has not been attained with any other form of engine yet introduced. The heated air, together with the gases produced by the combustion of the fuel, passes from the fire-box directly into the cylinder, so that every unit of heat produced is converted into force. The piston consists of a hollow plunger, to which the piston-rod is attached; the packing is placed around its upper circumference, where the heat is so moderate as to permit of efficient packing and lubrication. By means of an air-pump worked by the piston, the supply of air is forced into the grate. It here comes in contact with the fire, and a portion of it, in maintaining combustion, combines with the carbon, producing carbonic acid, &c., while another portion of the air in excess takes up heat, and is thereby expanded. The mixed heated air and gaseous products of combustion speedily accumulate such an amount of expansive force as to set the engine in motion, by pressing on the piston. At the end of the stroke the expanded gases escape by the waste-pipe, which may be connected by a stove-pipe with an ordinary chimney. Each upward stroke of the piston produces a downward corresponding stroke of the air-pump, and forces a fresh charge of cold air into the grate to maintain the combustion of the fuel, thus keeping up a continual supply of heated air and gaseous products. The power is increased or diminished by dampers, which pass the air through or over the fire according to the amount required. The chief advantages of the hot-air engine will be found in the very important facts, that there is not the most remote danger in its use; the furnace is perfectly insulated, all risk of fire is entirely avoided, and the presence of water, whether in large or small quantity, is dispensed with; so that this engine can be employed under circumstances where it would be impossible to use a steam-engine.

Father Secchi, a scientific experimentalist who is not usually mistaken in his statements, has lately made the somewhat startling announcement that red-hot iron is transparent. The reverend

Father had ordered a strong iron tube to be made. As it was intended for an apparatus requiring a vacuum, it was essential that this tube should be perfectly air-tight; and as he had some doubts about its soundness in this respect, in order to set these at rest, the tube was made red-hot and taken into a dark place, when there was clearly perceived through the iron (which was half a centimetre thick), a crack inside the tube, and which did not reach to the outer surface. Commenting on this, Dr. Adriani, in the 'Chemical News,' says:—"It is rather curious that the fact of the metal above alluded to, to which I have reason to believe that gold may be added, becoming transparent at red heat, should have escaped the notice of scientific men. It requires, however, a good bright red heat; but the transparency of the metals is evident thus even in daylight, as I know from my own experience while working in an engineering establishment attached to a large sugar refinery now many years ago."

Mr. Stock, another correspondent of the same paper, suggests what we consider to be the more probable explanation. He says that it is more likely that the crack exhibited itself, because where it existed the metal was thinner than throughout the rest of the tube, and would therefore cool more rapidly, becoming in consequence darker coloured, thus showing on the exterior both its extent and direction.

ELECTRICITY.—A very important modification of the magneto-electric machine has been suggested by Mr. Tisley, the very able and intelligent assistant to Mr. Ladd, and has been carried out by that instrument maker. It was suggested that if the armature had two wires instead of one, the current of one being sent through a wire surrounding the magnets, their power would be augmented, and a considerable current might be obtained from the other wire available for external work; or there might be two armatures, one to exalt the power of the magnets, and the other made available for blasting or other purposes. This idea has been carried out as follows:—Two bars of soft iron, measuring 7½ in. × 2½ in × ½ in., are each wound round the centre portions with about thirty yards of No. 10 copper wire, and shoes of soft iron so attached at each end that when the bars are placed one above the other, there will be a space left between the opposite shoes in which a Siemens' armature can rotate. On each of the armatures is wound about ten yards of No. 14 copper wire, cotton-covered. If the armature in connection with the electro-magnet is made to rotate, there will be a very feeble current generated in it; this passing round, the electro-magnet will increase its power with every additional impulse. It will thus be seen that the only limit to the power of the machine is the rapidity with which the armature is made to rotate, which is entirely dependent on the amount of dynamic force employed. The great improvement in this machine is the introduction of the second armature, which, although it takes off currents generated in its wire by the increased magnetism, does not at all interfere with the primary current; and when attached to a regulator is found to give an electric light equal to forty elements of Grove's or Bunsen's at the expenditure of 1-horse power. The machine exhibited by Mr. Ladd at the Royal Society was altogether rudely constructed, and was only intended to illustrate the principle; but with this small machine three inches of platinum wire ·01, could be made incandescent. There is no doubt that this principle is both ingenious and valuable, and Mr. Ladd deserves great credit for the enterprise he has shown in making the machine. But we cannot help asking why does he not in his published papers mention his assistant by name, and so give him the credit which he justly deserves for having made the original suggestion, instead of merely saying that it was "suggested by his assistant." Manufacturers are getting too much into the habit of considering that the credit of merely suggesting improvements is of trifling value in comparison with that of practically carrying them out.

A discussion on the theory of Mr. Grove's gas battery has lately been going on in the French Academy. Mr. Grove supposed that it was indispensable for each of the electrodes of platinum of his gas-couple to be simultaneously in contact with one of the gases, and with the liquid placed underneath. M. Gougoin, agreeing with M. Schönbein, states on the contrary that the action of the platinum does not take place except on the gases already below, and that the gas-receivers should only be considered as reservoirs to maintain the solutions they cover in a state of saturation. The electro-motive force of the gas-couple varies curiously with the state of the platinum wire. Its action is increased, as M. Matteucci remarked, by heating the elements in the flame of a spirit-lamp some instants before employing it. In the most favourable conditions, the electro-motive force of the gas-couple, constructed with platinum wires not platinized, scarcely exceeds 155, taking as unity the electro-motive force of a thermo-electric couple of bismuth and copper, the two solderings of which are maintained at the temperatures of 0° and 100° C. The electro-motive force of the couple of Daniell is represented by 193, and that of the couple of Volta by 178, at the moment of being set to work.

M. Jules Regnauld has examined the modification which mercury causes in the electric position of thallium. Experiments gave the following results. There is elevation of temperature, and thus a disengagement of heat, during the formation of the amalgam of thallium and mercury. Pure thallium is electro-positive to amalgamated thallium. These experiments prove that the position of thallium is much lower than that which separates cadmium from zinc in the Daniell's couple. They confirm this general proposition —"Every time that a metal is united to mercury, the place which it occupies in the scale of affinities is modified, and thermo-phenomena are observed."

Experiments on the elevation of temperature produced by the galvanic current have led M. E. Edlund to suppose that the current by a special action independent of that of heat, causes an expansion of the conductor which it traverses. He has therefore instituted experiments on that subject, and the result is, that the expansion is perfectly definite. The method adopted is as follows: He takes a metallic wire 1·184 metres in length, the amount of whose expansion by heat is known with perfect exactitude, and passes a current through it. The wire is stretched horizontally between a fixed clip and another working as a lever round a horizontal axis, bearing a mirror, and the measurement of the elongation of the wire is effected by observing the angular displacement of the mirror. If the temperature of the wire at the moment of observation be known, it will be seen whether its elongation accords with this temperature or not. To measure this temperature, M. Edlund measures the electric conductivity of the wire, and deduces the temperature from it. Now by this method he always finds a lower temperature than that which would correspond with the observed elongation, from which it follows that an elongation takes place in the wire independently of the action of heat. The conductivity is measured by the method of Wheatstone's Bridge. The rheostat is composed of two German-silver wires stretched upon a horizontal board. To determine the relation between the temperature and resistance, the wire is rolled round four glass pillars fixed in a wooden disc, and the cylinder formed by the wire placed in a glass vessel containing thermometers, and immersed in a bath the temperature of which was varied. The author gives details of several experiments, and concludes by stating that the current produces in the solid bodies which it traverses an expansion independent of that of heat; and although these investigations are not sufficient to make known the law of this expansion, they show that it increases rapidly with the intensity of the current, and also that this action does not cease immediately on the cessation of the passage of the current through it, but disappears by degrees.

Professor De la Rive has published an elaborate series of experiments on the propagation of electricity in highly rarefied elastic fluids; he finds that the transmission of the electric discharge through rarefied gases is accompanied by a sensible elevation of temperature; that when the gases are sufficiently rarefied for the discharge to pass readily, and for the light to be stratified, this elevation of temperature is less near the negative electrode than it is near the positive electrode; and that the absolute rise of temperature at the two electrodes, and the differences between them, vary with the density and nature of the gas. A fact which strikingly proves the great calorific and illuminating power of electricity is that hydrogen, under a pressure of only $1\frac{1}{2}$ millim., may be rendered luminous, and become sensibly heated by the passage of electricity, although at this pressure its density is so small that a cubic centim. of the gas weighs scarcely more than $\frac{1}{5000}$ of a milligramme. The gas must in fact have been very considerably heated for it to have been able to raise the temperature of a thermometer, of which the bulb filled with mercury was a cylinder $2\frac{1}{2}$ millims. in diameter and 3 centims. long, 3° in two minutes. The simple fact that the gas becomes luminous is a further proof of its high temperature; for its luminosity is evidently only a result of its incandescence. Professor De la Rive concludes his long and interesting paper by saying that [*] when one sees that so subtile a substance as hydrogen reduced to 1 or 2 millims. pressure is capable of becoming luminous under the influence of electricity, it is impossible not to be tempted to make a comparison between it and the likewise exceedingly subtile but still luminous matter which composes the nebulæ and cometary bodies. This analogy becomes still more striking when we examine closely the appearance presented, in a tube containing rarefied hydrogen traversed by the electric discharge, by the kind of mist which shows itself when a small quantity of gas is caused to enter the tube, and which likewise appears in the dark space when a certain degree of rarefaction has been passed. The gaseous matter is there even more highly rarefied than it is at the other parts of the mass, thus making its resemblance to the luminous matter forming the comets and nebulæ still more decided. We may add that recent researches on the part of various astronomers have shown that the rays yielded by the prismatic analyses of the light of these celestial bodies are exactly similar to those given by the electric discharge, when transmitted through rarefied nitrogen, and especially through hydrogen. Do these gases, then, which intervene in most of the phenomena of terrestrial physics, play an equally or even more important part in the phenomena of cosmical physics? There is nothing improbable in this conjecture, especially since the analysis of aërolites has shown that planetary space does not contain any element not found also upon our globe.

A curious experiment on the transportation of substances by the voltaic and induction current has been published by M. Lewis

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[*] 'Phil. Mag.,' xxxiii. 260.

Daniel, Professor of Physics at the Central School of Arts. It is generally admitted that the current of the pile moves in the interpolar circuit from the positive to the negative pole. The existence of a mechanical action exerted in this direction is confirmed by the movement produced in the carbon by the voltaic arc. It is evident also from the difference of level which takes place under the influence of a current, in a vessel divided into two compartments by a porous diaphragm, and enclosing a liquid of weak conductivity, which at the commencement of the experiment presents two surfaces of equal height at each side of the separation. The movement of the liquid, by the current discovered by Porret, has been examined by Messrs. De la Rive, Becquerel, and latterly by Windemann, who has determined its laws under certain conditions. It is possible to place in evidence this action of electricity, and to show the direction by an experiment more simple than the preceding. M. Daniel fills, with slightly acidulated water, a glass tube of any length, and of a diameter from ten to fifteen millimetres, bent at a right angle at its two extremities. He introduces into the liquid column a globule of mercury two or three centimetres long, and immerses the electrodes of a more or less powerful pile into the two vertical portions. By means of the globule of mercury the instrument is easily levelled. As soon as the current passes the globule becomes elongated and begins to move; going from the positive to the negative pole. If by means of a commutator interposed in the circuit, the direction of the current be changed, the globule stops and immediately takes an opposite direction, always from the positive to the negative pole. By properly moving the commutator, we can make the mercury take an indefinite alternating motion. The ends of the globule under the influence of the current do not present the same appearance. It is brilliant towards the negative electrode, and dull towards the positive one. This is owing to its possessing positive tension in front and negative tension behind. The oxide of mercury formed during the experiment is collected at the negative end, and is reduced, at least in part, by the hydrogen produced at the same time. If the liquid contain too much acid, a salt is formed which affects the transparency of the liquid, and bubbles of hydrogen are disengaged.

When the direction of the current is altered, a sort of veil which covers one of the extremities of the globule is seen to fly to the other extremity. Four Bunsen elements suffice for this experiment, if we employ a tube 0·40 m. to 0·50 m. long. With twenty-four elements we can operate upon a tube a metre long. The current of fifty elements gives too great a velocity to the mercury, and breaks it up into globules which travel in the same direction. When the tube is inclined the mercury can still move from the lower to the upper end. Thus the weight of the mercury being known, we can form a very clear idea of the work performed by the portion of the current which traverses the globule. If the inclination be progressively augmented, a moment arrives at which equilibrium is established between the force of the current which tends to make the mercury ascend and the action of the weight which causes it to descend, the globule resting stationary, but elongated. It is subject to a very apparent interior movement, and takes a rotatory motion, first in one direction, then in another. The same experiment can be made by means of a Ruhmkorff's coil. As the currents furnished by this apparatus are alternately in contrary directions, a commutator is necessary to suppress the inverse current. It is important to remark that the conductivity of the transported material is one of the necessary conditions of the movement; a globule of bisulphide of carbon introduced into the tube is insensible to the passage of the current. These experiments have a close similarity with those which Mr. Gore, F.R.S., described before the Royal Society some years ago.

The Abbé Moigno has brought forward a claim to be the first to make known the nature and application of the mysterious agent, ozone. In 1845, on the first news of the curious observations of M. Schönbein, he says he proceeded to Basle and visited this celebrated chemist. The abbé then wrote to the 'Epoque' a letter, inserted on December 31, in which the following very important passage occurs:—"It is necessary to return immediately to the ideas of Ampère, and consider the atoms of bodies as having two states—first, with the essential primitive electricity or in a nascent state; second, with their electricity more or less disseminated, or their atmosphere of electricity in a neutral state. The ozone of M. Schönbein is, in our eyes, only a molecule of oxygen in a nascent state, with only negative electricity in its atmosphere. I am, I think, able to rigorously prove and account for the wonderful properties of this agent that we cannot lay hold of, and of which so much has been said." The abbé says that he asks all chemists of that time, and Dr. Thomas Andrews, of Belfast, in particular, whether at that period any one had so clearly defined the essential nature of ozone: so much talked about, written upon, and discussed without any decided conclusion being arrived at. Two years afterwards the same reverend author asserted in the 'Nouvelle Revue Encyclopédique' of M. Didot, for July, 1847, the following more explicit statement:—"Sufficient attention has not been yet paid to the important fact that oxygen disengaged by plants is not in a neutral state. We are perfectly convinced that this nascent oxygen, without its positive atmosphere, is the ozone discovered by M. Schönbein, with an odour *sui generis*, and possessing, in the highest degree, all the properties of electro-negative substances. The bleaching of linen stuffs, ivory, wax, &c., in the open air, on grass, the formation of nitric acid and saltpetre, also many other phenomena, are only caused by the powerful action of oxygen in a nascent state, or with its negative electricity developed."

From 1845 to 1867 thousands of contradictory opinions have been written on the subject of ozone, but men of science are now returning to the idea clearly pointed out above. The Abbé Moigno has so often pleaded the cause and defended the interests of English scientific men, that we consider it a duty to lend our influence to establish his claim to this forecast of a great discovery.

11. ZOOLOGY (ANIMAL MORPHOLOGY AND PHYSIOLOGY).

(*Including the Proceedings of the Zoological Society.*)

MORPHOLOGY.

A new Gland in the Human Body.—Von Luschka of Tübingen drew the attention of Human anatomists lately to the presence of an undescribed gland situated at the terminal extremity of the human backbone, which he called the Coccygeal gland, comparing it with the pineal gland. Krause has since found the same body more largely developed in *Macacus cynomolgus*—and Meyer has examined the tails of the dog, rat, and mouse for a similar structure, but without success. In the cat, however, a similar structure was found. Meyer is inclined to regard this very remarkable body as similar to the caudal hearts or retia mirabilia, which are appendages of the arterial system in many animals.

Cervical Ribs in Man.—A case of a woman is recorded by Dr. Stieda of Dorpat, in which a pair of cervical ribs sprang from the seventh cervical vertebra. The ribs appear to have been well-marked fully formed pleurapophyses, and were attached by cartilage below to the sternum. The other vertebræ in the body were normal.

Professor Humphry on the Chimpanzee.—Two specimens of the *Troglodytes niger* have been dissected lately by the Professor of Anatomy at Cambridge, and he gives some account of his observations in the 'Journal of Anatomy and Physiology,' the second number of which has just been published. Professor Humphry makes some excellent remarks on the joints of the limbs, and points out the way in which structure is here concurrent with habit. He dwells on the differences between man and the ape, and discusses the use of the word Quadrumanous. If we are to regard that extremity of a limb which is adapted for grasping as a hand, then assuredly the ape's hind-limb-extremity is as much a hand as man's fore-limb-extremity; each differing in an exactly comparable manner from the feet (fore and hind) of the bear or dog. If, however, man's hand is to be the anatomical standard of comparison, Professor Humphry admits that there is a wide structural difference between the ape's foot and a hand. He seems inclined to favour the adoption of the term Chiropoda as a substitute for Quadrumana, a term which comes to us from Professor Halford in Australia, who has taken up this question as a strong Owenite, and has written a pamphlet on the monkey's foot.

Dentition of Marsupials.—Mr. Flower, the Conservator of the Museum of the Royal College of Surgeons, has quite recently communicated an interesting discovery to the Royal Society relative to the teeth of the Marsupial Mammalia. The lower forms of Monodelphous Mammals (*e.g. Bruta*) differ in their dentition from the higher, in having, as a rule, but one set of teeth, which lasts them for life, whilst the higher forms have a temporary set of teeth when quite young, whose place is afterwards taken by the permanent teeth—incisors, canines, and "premolars." From the examination of the jaws of adult marsupials, it appeared highly probable that they, although so low in the scale of mammalian life, resembled the higher members of the class in having a large milk or temporary dentition. Mr. Flower has succeeded in showing that this resemblance, like many others exhibited by the marsupials in relation to monodelphous mammals, is merely superficial. No marsupial, Mr. Flower finds, has ever more than four temporary teeth, and apparently all agree in having these four—one in the molar series of each half of each jaw. This tooth is succeeded by what is to be regarded as a premolar, and is chiefly remarkable for this, that it corresponds to that premolar (*viz.* the most posterior) in man and all the higher mammals, whose milk-predecessor is the first to develop, which appears earliest itself, and which in the various modifications of the dental series in the Mammalian class is the largest and most constant.

Sowerby's Whale.—The *Ziphius Sowerbiensis*, a rare whale of which there are only two or three specimens in the museums of Europe, is chiefly interesting as being one of the few living representatives of a very considerable group of dolphins, with long, firm, cylindrical snouts, called Rhynchoceti by Eschricht, and having teeth only in the lower jaw, and there but two or four of large size, almost like tusks. One of the known specimens of Sowerby's whale was cast ashore sixty years since in Elginshire, and its skull is now at Oxford. Another male specimen has lately been cast ashore on the coast of Kerry, and the head and teeth were procured in a perfect condition by Mr. Andrews, of the Royal Dublin Society. At a recent meeting of the Microscopical Society of London, Mr. Ray Lankester read a paper on the teeth of the Oxford specimen, in which he showed that they presented a very low type of structure (resembling fœtal teeth), corresponding to the degradation of their function from prehension or mastication to mere incidental "sexual marks." The structure of the recent teeth also threw some light on the nature and condition of fossil cetacean teeth in the Red Crag, called *Balaenodon* by Professor Owen.

Dentition of the Mole.—The teeth of the common mole have also recently received attention from Mr. Spence Bate, who is well known for his writings on teeth as well as for his more numerous observations on Crustacea. The dental formulæ in Insectivorous mammals is often a matter of extreme doubtfulness, and is one which can only be properly settled by the study of their development. Fred. Cuvier, Bell, De Blainville, Owen, and Blasius have each assigned a different dental formula to the mole. Mr. Bate has examined the jaws of young moles from the period when they have no hair on the body, and has satisfactorily shown what is the origin and what the antecedents of the permanent teeth. He considers that his observations confirm the formula given by Owen, *viz.*:—

$$\text{i}\ \tfrac{3}{3}\ \text{c}\ \tfrac{1}{1}\ \text{pm}\ \tfrac{4}{4}\ \text{m}\ \tfrac{3}{3} \times 2 = 44.$$

Mr. Bate's paper was communicated to the Odontological Society, and is published in abstract with a plate in the 'Annals' for June.

Ray Society.—'Nitzsch's Pterylography' is the title of the last volume issued by the Ray Society, having been translated by Mr. W. S. Dallas from the German. Pterylography is the study of the distribution of feathers, and their arrangement in "feather tracts," or "pterylæ," on the bodies of birds. Nitzsch was one of the most single-minded and persevering naturalists of his time—he devoted nearly the whole of his life to accumulating material for the present work, and one or two other matters relating to birds, to which class he entirely gave himself up. He died, however, before he could make up his mind to bring together his results. His friend, H. Burmeister, who succeeded him at the University of Halle, made it his first duty to do what he could with Nitzsch's material; and the German edition of 1840 was the result. The present translation is admirably performed, and the ten original plates of small folio size are well rendered. Before Nitzsch wrote, no one had made a philosophical attempt to discriminate the dermal appendages of any of the Vertebrata, beyond the rough division into Scales, Hairs, Bristles, and Feathers. He, however, has shown in a most masterly way, that there are definite regions marked out on the bodies of birds, which carry different sorts of feathers, and that these regions or pterylæ (feather-forests) can be compared and identified in different genera and species of birds, and that they furnish a means of classifying birds in a very natural way, limiting groups which are otherwise doubtful, and exhibiting their value and importance in other ways.

Pterylography is not a subject which has been much taken up in England; indeed the papers by Dr. Sclater and Mr. Bartlet appended to this volume are amongst the only contributions to its development in this country; hence Mr. Dallas's translation will be found acceptable by all scientific ornithologists, and ought to bear good fruit.

The Glass-rope.—The veteran zoologist Ehrenberg has communicated a paper on this much-discussed organism to the Berlin Academy. He, it appears, formerly considered the Hyalonema to be simply an artificial product of Japanese industry. He now abandons that notion, and gives his reasons for regarding it as a Sponge. At the same time he urges in a most curious way the vegetable nature of sponges, and regards the long hair-like spicules of the glass-rope as tending to confirm his view of the vegetable nature of sponges in general. He adduces the fact of the inhalent orifices of sponges being permanently open, as evidence against their animal nature, for no animals have a permanently open mouth; thus he attributes to zoologists who do not agree with him the view that a sponge is not a complex mass of units, but rather a few individuals conjoined whose mouths and anal apertures are respectively represented by the inhalent and exhalent orifices. Good evidence appears to have been brought forward in favour of the existence of a European species of Hyalonema; but this part of the question is certainly not yet definitely settled.

Excavating Sponges.—Mr. Albany Hancock, who in 1849 published a paper on these curious perforating organisms, has lately returned to the subject. He fully admits that at present the question as to the manner in which they excavate shells is not solved, their power being obtained perhaps by means of their spicula or by some other method. Dr. Bowerbank, in his Monograph of the British Spongiadæ, maintains that the minute galleries in the shells in which these sponges occur are excavated by "lithodomous Annelids." Mr. Hancock remarks that if this is so, we ought to find the annelid there, which we do not; only one annelid is recognized as perforating limestone, in the manner which Mr. Hancock attributes to *Cliona*, and that is a species of *Leucodore*. Mr. Hancock shows also very clearly that the dendritic and irregular character of the *Cliona* borings differs from anything similar done by worms. He describes four new species, characterized by the form of their spicula. They occur in the shell of a species of *Chama*; in the shell of a *Purpura*, from Mazatlan; in the shell of *Spondylus gœderopus*, from the Mediterranean; and in the shell of a *Serpula*, adhering to a *Chama* from Mazatlan.

PHYSIOLOGY.

The Blood and Work.—According to Hoppe-Seyler, the constituents of the tissues are oxidized *outside* the blood-vessels, and not after they have found their way into the blood, as maintained by Estor and Saintpierre. Hirschman opposes also the view that carbonic acid is formed *in* the blood at all. He maintains that it is formed in the tissues, and passes thence into the blood. Mr. C. W. Heaton, of Charing Cross Hospital, comes forward in the 'Philosophical Magazine' to maintain the view that oxidation takes place in the blood. His opinions will be found in his article on this subject in the present Number.

Regulation of the Heat of the Body.—Van der Hoeven was one of the first to point out the inaccuracy of the common division of animals into "warm" and "cold" blooded—the true expression of the difference not being contained in the words. What we call *cold*-blooded animals are those animals which have but little independent temperature, but vary almost equally with the medium which surrounds them. Warm-blooded animals, on the other hand, are such as have the power of *both* lowering and raising their own temperatures relative to that of the circumambient fluid. MM. Jacobson and Landré, of Utrecht, have recently made some observations on this power of self-regulation. Bergmann and Donders recognized in the skin the moderator of animal heat, and found that in its vaso-motor nerves the self-regulation takes place. In different animals particular parts of the skin are specialized as moderators. In the dog, the paws, nose, and tongue; in the ape, parts of the face; in cocks and turkeys, the vascular combs and gills, which usually have a low temperature, but under particular circumstances become very warm. The ears of the rabbit are perhaps the most remarkable of any of these organs, since they are provided with means of an alternate contraction and dilatation of the blood-vessels. MM. Jacobson and Landré have experimented successfully on the rabbit, and have fully shown that the ears have this important function; and further, that its exercise is entirely dependent on the sympathetic system of nerves.

The Croonian Lecture for 1867.—Dr. J. B. Sanderson's purpose in the Croonian lecture, delivered before the Royal Society, "On the Influence exerted by the Movements of Respiration on the Circulation of the Blood," was to show the incorrectness of the statement frequently made, that the frequency of the pulse is lowered and arterial tension diminished during inspiration. He shows, on the contrary, by experiments made upon dogs, that the immediate effect of inspiration as well as of exspiration, in natural breathing, is to increase both the force and frequency of the heart's action; and even when the trachea was plugged and stopped, the efforts at inspiration caused increase in the force and frequency of the pulse. This effect of inspiration is entirely mechanical, and is due merely to the expansion of the chest aiding the diastole of the heart, for it has been found, *cœteris paribus*, that whatever tends to assist the diastoic movement increases the force and frequency of the contractions of the heart.

MISCELLANEOUS.

Recent Publications.—Mr. Andrew Murray, F.L.S., has given to the world a most sumptuous volume on the Geographical Distribution of Mammals. It contains some most excellent and elaborate maps, is printed most charmingly, and is published by Day and Co. It is, however, only to be regarded as a compilation, and we regret to say that even as such is deficient with regard to two or three cases in which we happened to test it. Mr. Murray's original views ennunciated in certain parts of the book cannot carry much weight; at the same time, the book is a pleasing contribution to zoological literature.

The last Part issued of the Philosophical Transactions of the Royal Society contains Mr. Charlton Bastian's very elaborate researches on the Nematodes, illustrated by many plates. It also contains the first part of Dr. Carpenter's memoir on *Autedon* (*Comatula*) *rosaceus*. This memoir is, indeed, such a one as might be looked for from its talented and learned author. After spending the earlier part of his life in the preparation of those valuable books which are so well known, Dr. Carpenter now intends to devote himself (as he says in the preface to the last edition of his Human Physiology) to original observation. This beautifully illustrated and elaborated memoir is an indication of what we may look for.

Obituary.—It is with true sorrow that we record the death during the past quarter of one of the most eminent and laborious of British anatomists—John Goodsir, Professor of Anatomy in the University of Edinburgh. Together with his brother Harry (who perished in the Franklin expedition) and Edward Forbes, he wrote many valuable zoological papers, and became a Fellow of the Royal Society of London in 1846, after communicating through Professor Owen his well-known paper on the supra-renal, thymus, and thyroid bodies. About the same time he was elected to the Edinburgh chair of anatomy. The lectures which he there gave are among the most remarkable productions of their kind, containing no mere digest of manuals and text-books, but forming rather the means by which he communicated to the world his own original philosophical views and important observations on the matters which he discussed. For many years he suffered from paralysis of the lower extremities, which at last ended in his death. He was in his fifty-fourth year. Dr. Wm. Turner, who was for many years demonstrator and assistant-professor, has been elected to the Professorship, and has already given hopes, by his anatomical and literary labours, of being no unworthy successor to his great master.

PROCEEDINGS OF THE ZOOLOGICAL SOCIETY.

The papers read at this Society during the past quarter have been as varied and interesting as usual.

Relating to Mammalia, Mr. Thomson sent a communication on a deformity of the lower jaw of the sperm whale (*Physeter macrocephalus*), and Dr. Macalister has given some details on the anatomy of a cetacean (*Globiocephalus*) recently stranded on the coast of Ireland.

Mr. St. George Mivart, who is making himself a good name as an osteologist (*vide* his paper on the "Osteology of the Insectivora," in the 'Journal of Anatomy and Physiology,') has read a paper "On the Structure of the Skull of the *Propithecus diadema* of Bennett;" and Dr. J. E. Gray has furnished an important essay on the skulls of the Felidæ, in which he has carefully pointed out the variations which occur in this part of the structure of the different members of this group of animals. Professor Allman, who recently described to the Society the details of structure of the *Potamogale velox* of M. P. B. du Chaillu, in which he showed that it was an Insectivor, and defended M. du Chaillu's claim to its discovery, has communicated some further supplementary observations on this highly interesting animal.

Relating to Birds, we have some papers of more than usual value. Professor Huxley, who has been working at this class in connection with his Hunterian lectures, has put forward quite a new classification of these animals based upon their cranial structures. The classification is mainly founded upon the characters presented by the bones of the palate. It was proposed to divide the class Aves primarily into three divisions:—1st, the Saururæ, containing only the fossil *Archæopteryx;* 2nd, the Ratitæ, containing the struthious birds; 3rd, the Carinatæ, containing all the other birds. The Carinatæ were subdivided into four great groups, distinguishable by cranial characters, and denominated Dromeognathæ, Schizognathæ, Desmognathæ, and Œgithognathæ. These contained altogether sixteen alliances, which were further divisible into families. Dr. J. E. Gray, who was in the chair when this paper was read, remarked at its conclusion that he considered internal characters as of but very little use in classifying animals. Dr. J. Murie, the Society's Prosector, has made some observations on the Tracheal Pouch of the Emeu (*Dromæus Novæ Hollandiæ*). He discussed the structure of this remarkable organ and of the opening of the trachea into it, and made some suggestions of its probable use in the bird's economy. The birds added to the Society's menagerie have been from time to time noted by the Secretary. Amongst others the various species of gulls, and especially an example of *Larus fuscescens* (Licht), from Mogador, were remarked upon. Mr. Gould has described a new bird from the interior of South Australia, which he proposes to call *Malurus callainus;* and other short ornithological papers have been laid before the Society. No Reptiles appear to have engaged the Society's attention during the quarter, but we have a few papers on Fishes. Amongst these are those of Dr. F. Day, "On the Fishes of the Neilgherry Hills and Rivers," and two by the same author "On Fishes from Western India."

New Mollusca from China have been described by Dr. Baird and Mr. H. Adams, amongst which were some interesting forms of Unionidæ collected at Shanghai by Dr. J. Lamprey.

The Coleoptera of the Azores have formed the subject of a communication from Mr. G. R. Crotch, in which he has given an account of a very fine collection of these insects formed by Mr. F. Godman during a recent visit to those islands.

The interest in the beautiful Lace-sponge has been augmented by a communication from Dr. Bowerbank on *Euplectella speciosum* (Owen), in which he gave a detailed account of the structure of this organism. Dr. J. E. Gray has brought before the Society some new genera of Sponges, and at the same time gave some notes upon a new classification of the class.

THE PUBLIC HEALTH.

London.—The principal feature in the Sanitary Legislation of the quarter has been the introduction of a new Vaccination Bill. The necessity of further legislation on the subject of vaccination has been felt by the alarming fatality of the present epidemic of smallpox, which has been very fatal in London, and has extensively prevailed in the provinces. This epidemic is still continuing, and existing legislation has been found quite unable to ensure the vaccination of the community. So prevalent has been the smallpox, that some persons have asked the question as to whether the cowpox is so perfect a preventive of smallpox as we have been led to consider it. With regard to this question, it may be asserted with the utmost confidence that where the disease of cowpox has been properly communicated to an individual, in such cases there is no more tendency for such an individual to take smallpox than if he had had smallpox itself. There is in a very small number of cases a tendency amongst persons who have had smallpox to take it again. It is, however, very questionable as to whether this number is at any time sufficient to keep up the smallpox in a community. We have also abundant evidence to show that in communities where the practice of vaccination is carefully carried out, there smallpox is only an exceptional visitor.

When the practice of vaccination was first introduced by Jenner in this country, the demonstration of its being able to prevent smallpox was so complete that it was never contemplated that there would be any persons who would neglect for themselves or their families so important a means of preventing a foul and fatal disease. Every adult in the country had more or less personal experience of the fatal nature of smallpox, of the loathsome character of its symptoms, and the deformities it inflicted on those who had had it. But gradually these recollections passed away, and there sprang up in the community persons belonging to the party of medical impostors who maintained that cowpox did more harm than smallpox, and thus an indifference to vaccination has been engendered. It was then sought by legislation to remedy the consequences of this indifference, and powers were given to the Boards of Guardians to superintend the vaccination of their districts. Up to the present time this legislation has failed to secure the object desired, and a new Bill is now passing through the House of Commons for the purpose of improving the old Acts. Without going into the details of either the old or new Bills, we would observe that in all there is the same fatal oversight which must render impotent all attempts at vaccination legislation. In England and Wales we have no compulsory registration of Births, and consequently there are no existing means of ascertaining whether every child born is vaccinated. In some districts in London it is believed that 25 per cent. of the children born are not registered. Yet in spite of this, the legislation assumes in its Vaccination Bills that every child born can be easily discovered for the purposes of vaccination. The necessity of compulsory registration in England and Wales has been pressed upon our Home Secretaries, on Poor Law Secretaries, on Presidents and Vice-Presidents of Privy Council for years, and not the slightest effort has been made in Parliament to secure a return of births, upon which alone can be founded any accurate statistics of the relations of birth to death in the kingdom.

Another reason of the failure of our Vaccination Acts has been the small sum given to public vaccinators for performing the operation of vaccination. The former Acts named 1*s*., and the present Bill offers 1*s*. 6*d*. Now our legislature ought to know that this is no payment for professional service, and that an operation requiring skill and attention will never be properly performed for such a payment. The operation thus paid for is entrusted by medical men to their apprentices and assistants, no satisfactory evidence of the operation being properly performed is ever given, and thousands annually undergo a sham operation, and are let loose on society to take and propagate the smallpox. It is a well-known fact that in parishes where higher fees have been given to the public vaccinator than the minimum allowed by the Act, that there smallpox has not been known. Give the medical man an interest in looking after the cases of unvaccinated children and he will do so, and there will be no need for an elaborate system of certificates or inspectors. The fact is, if enough is paid to make it the interest of a respectable medical man to see after unvaccinated children, and also to ascertain that the vaccination has been properly performed, there hardly needs any further legislation.

In a paper on Vaccination, recently published by Mr. Rumsey, of Cheltenham, whose opinions on State Medicine are always entitled to respect, he states his conviction that no compulsory Vaccination Act will ever succeed in this country. He advocates indirect compulsion by refusing admission into schools, factories, and all kinds of service, unless proof should be given of successful vaccination. He also advocates the removal of the superintendence of vaccination from the hands of the Poor Law authorities, and the placing it in the department of the Medical Officers of Health who are appointed by the vestries.

Amongst the sanitary subjects demanding the attention of the legislation, is that of sea-scurvy. There is no doubt an increased tendency to the development of this disease on board our mercantile marine. The prevention of sea-scurvy is as simple as that of small-pox, but neither masters nor men will voluntarily adopt it on board our ships. We have a law compelling ships to take out lemon-juice, that it may be served to men on voyages beyond a certain duration. But if the sailors will not inform there is no one to prosecute. There ought to be a much more vigilant superintendence of ships going long voyages. At any rate the law might compel captains to take out lemon-juice, and when ships arrive with scurvy on board, an investigation as to its cause should immediately take place. The duty of superintendence should be placed in the hands of the Medical Officer of Health, when there is one in the port from which the vessels sail, or a special Medical Officer of Health should be appointed for this duty.

Up to the present time no alarming outbreak of cholera in large populations has been reported this year, either in this country or on the continent of Europe. We may hope, therefore, that for the fourth time in the present century this plague has retired. It would be well if we could hope that the lessons taught by the last outbreak would be sufficiently impressive to render any further outbreak impossible. We have learned some new facts in the last outbreak—we have had old impressions confirmed, and some old prejudices removed. There is no doubt now that the cholera is brought here from the East, and that it travels by means of human intercourse. The cholera epidemic of 1866 has shown more clearly than ever that this disease is dependent on a special poison, and that this poison is capable of being conveyed more particularly by the agency of water. The several outbreaks of the cholera in the towns of the continent showed that in all probability the water supply of these towns had become contaminated, whilst the outbreak of the cholera in London, confined almost entirely to one district, and that district having an impure supply of water, confirmed the suspicion which had been created by the history of the outbreaks of cholera in 1848 and 1854, that the drinking-water of the metropolis was the principal means by which the poison of the disease was propagated.

An interesting meeting for the purpose of deliberating on some questions connected with cholera, took place at Weimar on the 28th and 29th of April last. This meeting consisted chiefly of German physicians, of whom the most distinguished were Professors Pettenkofer and Griesinger. Mr. John Simon attended from England. There were about sixty physicians present. The questions proposed for discussion were as follows:—

1. The causes of the spread of cholera.
2. The advisability of using disinfectants.
3. The nature of disinfectants.
4. Points for further investigation.

With regard to the first question, the conference was unanimously of opinion that cholera is spread by means of a poison. Of the nature of the poison, there was not sufficient evidence to arrive at any definite conclusion. Dr. Klob, of Vienna, and Dr. Thomé, of Cologne, both exhibited specimens of low organisms that they had discovered in the dejections of cholera patients. These forms were cellular, and produced by germination fungoid growths similar to those found in moulds. The Conference received with much caution these communications. It will be remembered that in this country in 1848, Drs. Britton and Swayne, of Bristol, discovered germs of a similar nature in cholera investigations. There was every reason to believe that the organisms then found were not peculiar to cholera, but that they were organic bodies of various kinds that had probably been taken into the intestines by food. Too much caution cannot be exercised in coming to conclusions with regard to the significance of these so-called cholera-spores. With regard to the propagation of cholera by drinking-water, Mr. Simon brought before the Conference the experience of London in the three last epidemics. The demonstration of water conveying the poison has not been apparently so complete anywhere as in London. Professor Pettenkofer laid his researches upon the influence of soil on the production of cholera before the Conference. He maintains that soil overflowing with sewage, and suddenly becoming exposed from the sinking of the ground-water, is a *nidus* for the spread of cholera-poison. This subject was one which the Conference agreed required further investigation before any fixed laws could be laid. On the second point, the utility of disinfection, the Conference was quite agreed. Where disinfectants had not succeeded, the causes were clearly pointed out, as in the movements of troops, thoroughly bad buildings, and overloaded drains and cesspools, or the use of impure drinking water. The disinfectants especially recommended by the Conference were carbolic acid and sulphate of iron. The latter disinfectant has not been much used in England, but it has one qualification that has led to its being recommended by Professor Pettenkofer, and that is its permanency and acid reaction. Other disinfectants, as chlorine, carbolic acid, and the permanganates, act well immediately, but lose their power in the course of a little time. The Conference recommend a mixture of carbolic acid and sulphate of iron for ordinary disinfection. For soiled linen it was recommended that it should be boiled, and then dipped in a solution of sulphate of zinc. This should be constantly used for water-closets, drains, cesspools, and accumulations of vegetable and animal matter.

The Conference recommended that attention should be given to the following points:—1. To lower organisms in reference to cholera. 2. To the influence of drinking-water. 3. The condition of the soil and the influence of the height of ground-water. 4. Whether cholera be transmitted through goods. 5. The relation of cholera to other diseases coming after. 6. The spread of cholera on board ship.

We may add to these notes on cholera that a Commission appointed to inquire into the supply of water for the East London Water-works have reported and confirmed the worst suspicions with regard to the impure nature of the supply of water to the people of the East of London in July last. Captain Tyler also, in a report made to the Board of Revenue, has confirmed all these statements of the impurity of the East London water-supply. Whilst refraining from giving an opinion as to whether this water contained the poison which killed the people in the East of London, he gives a fearful picture of the wretchedness of many districts that he visited. He clearly shows that during last summer large numbers of families had a deficient supply of water, and gives pictures of the dirt and misery of people for want of water that ought not to exist in a country where there is a legislation professing to care for the poor on the one hand, and a water company with plenty of water to supply on the other. It is painful to contemplate the unworthy reasons that are assigned by people in power for not exercising the slightest authority in removing from their poorer neighbours the cause of disease and death.

In our last number we mentioned that a deputation of the Social Science Association was about to wait on the President of the Privy Council for the purpose of urging upon him the necessity of an amendment and consolidation of the laws relating to public health. The Duke of Marlborough and Lord Robert Grosvenor, the President and Vice-President of the Privy Council, with whom was Mr. John Simon, received the deputation on the 2nd of April. Their Lordships were addressed by Mr. Rendle, Dr. Lankester, Mr. Rumsey, Mr. James Beal, and Dr. A. P. Stewart. The point chiefly urged by the speakers, was the want of anything like unity in our sanitary legislations.

Mr. Rumsey, so well known for his work on State Medicine, urged the necessity for the union and consolidation of central authority in sanitary matters, which is at present distributed between the Privy Council, the Home Office, the Poor Law Board, and the Registrar-General, producing uncertainty and confusion in local administration. He also pointed out the great anomalies which mark local administration in the provinces, the variety of boards existing under poor-law and local government and Public Health Acts; and the remarkable difference in the area and population of the districts under these several boards, the inhabitants of a district varying from less than a hundred to many thousands. He recommended an improved constitution of local boards with higher qualifications for their members and the extension of areas of local government, so as to provide for an economical and efficient administration of the health laws. He showed how this extension of area affected the appointment of health officers, and urged the necessity for an entirely different system of those appointments which in the provinces were made under the Public Health Acts. He instanced the inspection of factories and work places, especially the extension of the Factory Acts now before the House of Commons as a reason for appointing a highly qualified class of officers rendered independent of private practice and debarred from it. He noticed the importance of such independence as regards certificates of health, age, and fitness for labour of the children employed. He also mentioned Mr. Torrens's Bill for dwellings for the labouring classes as requiring the action of a health officer, who ought certainly to be independent of the proprietors and householders of the wretched hovels he might have to condemn. The basis of an improved organization, he considered, was to be found in the registration divisions of the country which are identical with the poor-law unions. It is in these districts that the great facts of disease and mortality are recorded; in these, therefore, a scientific officer is especially needed, both to correct and verify those returns, and to apply them to the suggestion of practical remedies. It would be a most false step in sanitary legislation to compel every small local board to appoint its own officer of health on its own terms. He warned the Government against enforcing, or even encouraging the present defective system of these appointments, and urged the importance of making a new organization of scientific persons the foundation of a truer sanitary reform.

Dr. A. P. Stewart drew attention to the want of Health Officers throughout the country. In London alone was the appointment of officers of health imperative, and he showed that the size and population of their districts varied enormously, as also their salaries, one having as little as twelve guineas, another as much as 1,000*l.* a year. Only in nineteen out of fifty-nine large districts were health officers appointed, and the average of inspection was in London one to 34,000, and in provincial towns one to 42,000, of a population, rendering impossible any effectual inspection or removal of nuisances. And, as if to complicate matters still more and to prevent any hearty co-operation in carrying out sanitary improvements, the inspectors of nuisances were in not a few instances independent of the officer of health, under whose control they should always be placed.

These remarks afford a lesson, and hit a blot in our sanitary legislation. The Metropolitan Management Act made it compulsory on the vestries to appoint medical officers of health. The consequence has been that London has got its medical officers of health, and in districts where the vestries are not wholly abandoned to the worship of dirt, a great deal of good has been effected. But the drawback—the blot in this otherwise excellent arrangement—is that the Act gives the vestry the power to elect these officers, and to name their salaries. The consequence is, that in one instance a vestry has had the insolence to offer its medical officer of health, the magnificent stipend of twelve guineas a year. Not one single vestry in London can be said to have behaved honourably and trustworthily in this matter. Saint Pancras, after having appointed an efficient officer of health, and given him 400*l*. a year for two years, deliberately reduced it to 250*l*. a year, without diminishing the duties of the office. Saint Marylebone, on the death of Dr. R. D. Thomson, handed over the office to his successor on the condition that he accepted it for 300*l*. a year. Paddington has just reduced the salary of its health officer from 300*l*. a year to 250*l*. Saint James, Westminster, the richest parish in London, reduced the salary of its health officer four years ago from 200*l*. to 150*l*. a year.

During the past quarter, two interesting discussions have taken place in the Health Department of the Social Science Association. The first was on the Fourth Annual Report of the Coroner for Central Middlesex. On the reading of the paper on the 13th February, there was a general discussion, and the following points were reserved for an adjourned meeting:—1, the propriety of appointing special experts to conduct post-mortem examinations at coroners' inquests; 2, the advisability of introducing the inquiries of the Coroner's Court in every case of death in workhouses; 3, the necessity of erecting public mortuaries in the metropolis otherwise than in connection with workhouses.

Dr. W. Farr was in the chair, and the following resolutions were carried:—

"That this meeting is of opinion that it is desirable that attached to the Coroner's Court there should be special medical officers, unconnected with private practice, and publicly appointed to investigate the cause of death and report it to the jury."

"That larger powers should be given to the coroner to call in a second medical opinion in any doubtful or obscure case."

"That the special officer proposed in the preceding resolution should, as soon as practicable, be the medical officer of registration proposed by Dr. Farr, and should act as the Officer of Health, who ought to be appointed in every registration district throughout the country."

"That it is the opinion of this meeting that public mortuaries ought to be erected in proper places for the prevention of the spread of infectious diseases, for the conveniences of the Coroners' courts, and for other purposes."

"That it is desirable that notice be given to the Coroner of every death that occurs in a workhouse, as of those which occur in county lunatic asylums; and that the Coroner have power to hold inquests in all cases in which he deems inquiry necessary."

Mr. Curgenven's paper, "On the Waste of Infant Life," was read on the 18th of March, and gave a truthful but alarming picture of the loss of infant life in England. He showed that one of the most fruitful sources of death amongst infants was the practice of weaning them at an early age and feeding them by hand. This was especially the case with illegitimate offspring; if those unfortunate infants escape murder at their birth, it is only to undergo a long process of painful extinction by hand feeding. Mr. Curgenven showed that honourable marriage was no protection to the hand-fed child. At the adjourned discussion on the 13th of May, Dr. W. Farr in the chair, the following resolutions were carried:—

1. "That it is desirable for the checking of the excessive infantile mortality in manufacturing towns where women are employed, that a maternity fund be established in connection with each factory, out of which the lying-in woman should receive a sum equal to her weekly wages, and in lieu thereof, for a period of two months from the birth of her child, provided it lives, to enable her to devote the necessary maternal attention to it."

2. "That every encouragement should be given to the establishment of infant day-nurseries, where the young children of female operatives, and other working women, could be properly cared for in the absence of their mothers at work."

3. "It having been proved that very great mortality exists among illegitimate children in the care of hired nurses, a fact which shows the existence of much ignorance, carelessness, and culpable neglect on the part of these nurses, the Health Department of this Association is of opinion that protection should be accorded by the State to illegitimate children, by requiring that all persons taking charge of them should be registered, or licensed, and placed under the supervision of the Poor Law Medical officer of the district in which they reside."

During the discussion Dr. Rogers, medical officer of the Strand Union, made some valuable and practical remarks. He said, "In the treatment of weaned children under his care, he always endeavoured to provide some human milk, were it ever so little, for such children. To children under six months of age, no food should ever be given which was warmer than blood heat; warmer, in fact, than the milk when it left the mother's breast. The most complete cleanliness was also necessary with regard to the food of young children. He believed that one-half the diarrhœa, from which young children suffered was caused by keeping their food, especially their milk, in dirty vessels. It was also important that their food should be rightly compounded: a quarter of a pint of water to a pint of pure cow's milk (with a little white sugar added) was the right proportion. Another point to be remembered was, that hand-fed children needed a warm temperature, to compensate for the loss of warmth which they sustained from want of constant contact with their mothers."

The public mind has been suddenly excited by the announcement that the "Black Death" had appeared in Dublin. It will be satisfactory to the public to know that from January to the present month fifty-seven cases only of a fever which has got the above name applied to it, has occurred. The symptoms are those of great prostration, with the appearance of purple or almost black spots under the skin. These are the symptoms of severe typhus, and at first this was thought to be the character of the disease. Dr. Mapother, however, the acting Medical Officer of Health for Dublin, has already carefully investigated the disease, and has come to the conclusion that, unlike typhus, it is not a communicable disease. The first cases were more sudden than those which have occurred subsequently, and the disease has been most prevalent in the most unwholesome parts of the city. Its principal symptoms in the milder cases are like those of the cerebro-spinal arachnitis which prevailed in 1866 in West Prussia. This disease was reported on by Dr. Sanderson, who was sent over by the English Government to investigate its nature, and he came to the conclusion that it was non-contagious. It is to be hoped then that in this somewhat novel disease we have no reason to fear its spreading so long as proper sanitary arrangements are enforced.

Turning now to the sanitary condition of some of our large towns, we have to report as follows:—

MANCHESTER.—The sanitary condition of Manchester has not, during the last quarter, at all improved, nor have any effectual efforts been made by the authorities to amend it. The average death-rate has continued to be as high as that of any large town in the kingdom, and in some weeks Manchester has stood at the head of the black list. The deaths from continued fever, which in 1863 were little over 300, amounted in 1866 to 1,061, and up to the end of the first quarter of the present year they were nearly as numerous. Diarrhœa also, another certain indication of a *poisoned atmosphere*, has been almost as fatal.

The worst feature of this deplorable state of affairs is the apparent indifference of the inhabitants to the subject. The apathy they display is something marvellous. A comparatively trivial matter, such as a change ordered by the Council in the omnibus routes, has produced scores of letters to the newspapers, many indignation meetings, and heated and angry deputations to the Council. But the tale of thousands of preventable deaths, of children made orphans, of desolated homes, has appeared to fall almost unheeded on the public ear. Are the men of Manchester so entirely devoted to money-getting that they can spare no time for these things? Is the price of cotton, or the value of railway shares so much more important than the moral and physical well-being of those by whose labour they gain their wealth, that they cannot give even a few minutes to its consideration?

Their indifference is the more remarkable because the organs of public opinion both in Manchester and London have striven to direct attention to the subject. The local press has nobly done its duty. Articles have from time to time appeared which ought to have pierced the hide of the most pachydermatous of councillors. Indications are not wanting that these attacks are at last beginning to tell. The Council have shown an approach to a suspicion that their position of passive resistance will not much longer be tenable. They have at least ceased to affect absolute indifference to what is said of them. At the annual meeting of the subscribers to the Children's Hospital, held early in April in the Mayor's parlour, with the Mayor in the chair, the medical officers to the charity ventured to present a report, in which they said that they would not have so many cases of typhus to heal, "if ordinary attention were paid to the sanitary condition of the city." The mayoral dignity was offended by this imputation on the Corporation, and his worship refused to put the motion that the report be received unless the obnoxious passage were expunged. An animated discussion ensued, in which it would be difficult to say whether more ignorance or hardihood of assertion was displayed by the defenders of the Corporation, but which ended, after the omission of the objectionable sentence, with an acknowledgment from the Mayor that the sanitary condition of the city was not in all respects what it ought to be. The subject was brought before two subsequent meetings of the city Council. The original report of the physicians to Children's Hospital was quoted, as well as the article on the Health of Manchester in our last number, and while some members of the Council strenuously denied the truth of the allegations of municipal neglect, others admitted that there was too much foundation for them. The corporate rulers of Manchester are evidently not all of one mind. By placing every member of the Council on the General Purposes Committee, by which the real business of the Corporation is transacted, and from whose discussions reporters are excluded, they have done all in their power to conceal their dissensions. Enough has, however, oozed out at the public meetings to show that they are not a happy family. It has been shown, too, that recent exposures have not been without practical effect. The attempt to enforce the payment of a tax for the removal of dry ashes, and thus to check the use of water-closets, has been at least deferred. An audacious attempt by one of the Committees to reopen some cellar-dwellings of the filthiest and most abominable description, and which the Council had therefore ordered to be permanently closed, was at the last meeting of the Council defeated by a majority of 26 to 20. It would be well for the ratepayers at the next annual election of councillors, to look after those of the minority who shall then present themselves for re-election. This vote shows that the majority of the Council are at least unwilling to go backward in sanitary matters. If they are not at present prepared to take decided steps in a forward direction, allowance must be made for the difficulty of their position. Neglect, not altogether their own, but in part that of their predecessors in office, has permitted the causes of disease in Manchester to grow to a magnitude sufficient to appal the most courageous of sanitary reformers. Fifty thousand middens such as were described in our last number cannot be converted into water-closets, or even into dry-closets; twenty-five thousand back-to-back houses cannot be demolished and rebuilt on a more rational plan, except at an enormous cost. That cost the public mind of Manchester has probably not yet risen to the height of calmly contemplating. Pressure from the executive under, probably, a more stringent law than now exists, will have to be applied before the needful work is done.

But if the authorities are not yet prepared for vigorous action in this direction, they may at least do something to diminish the nuisances they are themselves perpetually creating. Surely the more right-feeling members of the Council cannot be conscious of the trouble, the discomfort, the absolute misery, to say nothing of the injury to health, which their servants still produce by their mode of removing the night-soil. If they wish to prove that they are really anxious to improve the health and comfort of their fellow-citizens, as well as to set them an example of cleanliness, let them order every night-soil cart to be followed by a water-cart containing a deodorizing solution, with which the foul traces of the nocturnal doings of their servants may be washed into the sewers. Let them order the men thoroughly to empty the ashpits, and cleanse them with a similar solution, instead of, as is now too often the case, picking out only the more choice and richer portions of the soil, leaving the greater part of the ashes saturated with liquid putrescent organic matter to poison the surrounding atmosphere. And let them also take steps for the early removal of the mountain of mingled excrement, slaughter-house refuse and ashes, now standing in their depôt in Water Street. And they may at least discontinue their active opposition to such measures as the Bill of Mr. M'Cullagh Torrens for the improvement of the dwellings of the working classes. To use the weighty words of a local weekly contemporary:—"The insalubrity of Manchester may proceed from causes altogether beyond their ken, but we do say that in the exceptional, and by no means flattering position in which they stand, the Corporation would have shown more shrewdness, if not more decency, by keeping quietly in the background on this occasion."

The Corporation of Salford continue to show the superiority to their neighbours which has for some time honourably distinguished them. They have a Bill now passing through Parliament which will enable them to deal more effectually than hitherto with the many causes of disease identical with those of Manchester existing in their borough, and to appoint a Medical Officer of Health to advise them in the performance of this good work. They have recently sucessfully resisted an attempt by a powerful company to establish an abattoir and dead-meat market in a central and very populous situation, because they believed that an enormous nuisance would thereby have been occasioned. While the corporate rulers of Salford have thus been doing their duty as guardians of the health of the community, those of Manchester have quietly been permitting the erection on the bank of the Irwell, in a situation almost central to the two towns, of a piggery for several thousand pigs, and a slaughter-house in which those very cleanly and odoriferous animals are to be prepared for the pork-shops.

LIVERPOOL.—In somewhat striking contrast to the absence of sanitary proceedings in Manchester, is the unwonted activity of the officials in Liverpool. The sanitary cases are now tried by the Stipendiary, and every week scores of people are summoned either under the new Act of 1866, the Nuisance Removal Acts, or one of those numerous local Acts with which the Corporation has from time to time armed itself. Cellars, not in conformity with the Act, are closed; tenants fined for not cleansing, whitewashing, or converting the old into the new conveniences. The manufacturers, bakers, &c., are prosecuted for making an unnecessary quantity of smoke; and if the worthy magistrate would only ascertain by practical observation, better than the officials seem to know, what is an unnecessary quantity, this along with all the other sanitary reforms referred to would be a most useful movement.

About twenty thousand pounds' worth of land was bought in Liverpool about eighteen months since for labourers' dwellings, and the Corporation have not yet been able to decide upon plans, certain plans having been prepared and altered so as not to be in conformity with sanitary regulations.

The condition of Vauxhall Ward, which had obtained almost an European notoriety, is much improved, but the local authorities still refuse to comply completely with the instructions of the Home Office, in conformity with Mr. Taylor's report. Mr. B. Samuelson, M.P., has written to the Health Committee that the report will shortly be printed. We hope the honourable gentleman will see to this, as the people of Manchester are waiting for its publication before they commence taking steps adverse to the continuance of the present system of defæcation there.

In the matter of water supply, Liverpool still stands in an unsafe position. The people of the town had been led to believe that the Corporation meant to be guided by the Royal Commission, but as recently as the 15th May they had not placed themselves in communication with the Commission, although the Liverpool water engineer, whose advice is taken by most other towns, was examined before the Commission. By the time the Liverpool people have made up their minds where to go for water, they will find every available source occupied.

A member of the Liverpool Town Council, Mr. W. Dawbarn, has published a series of pamphlets on the Sanitary Condition of Liverpool,* in one of which he reminds Dr. Trench, the medical officer, that whilst over 484,000*l.* have been expended upon sanitary works, "we are worse off in our results than before we commenced our so-called improvements." Although the author of these pamphlets is quite right in believing that it is unsafe to provide water-closets without ensuring a sufficient supply of water, yet we think the pressure should be brought to bear, not upon those who are doing their part of the work of conversion, but upon those others who neglect to provide the necessary and proper auxiliary, the supply of water.

A large amount of angry and bitter recrimination is introduced into these discussions, and the Liverpool Sanitary Association, who, to use an expressive simile of Dr. Trench, have "been blowing the bellows" for the Corporation for some time past, have fallen in for a larger share of odium and abuse than usually rewards the efforts of those who seek to benefit the community. Such cries of pain, however, always accompany the operations which are necessitated by the long neglect of dangerous sores, and whilst Corporations must learn to bear and be thankful even for the sharp incision of the knife, or the suffering which accompanies the healing process; so, too, should the operators be prepared for a good deal of noise and ingratitude on the part of their patients.

Two new parks are being prepared for the townspeople. One on which much money is likely to be lavished is at the south end, and is said to be intended to protect the grand folks from the intrusion of the commonalty. The other, Stanley Park, is at the extreme north, and although it at present consists of a number of fields only, it affords a splendid recreation-ground for the poor who reside in the crowded and unhealthy wards.

Taking all in all, therefore, there is much to praise, even if there be much to blame, in the action of the local authorities of Liverpool; and we hope to be able, in our next, to report further progress.

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* 'The Sanitary Condition of Liverpool.' By William Dawbarn. Liverpool: J. Woollard.

Leeds.—Those who for some years past have been endeavouring to rouse the custodians of the public health in Leeds to a sense of their responsible duty, may at last congratulate themselves that their efforts have not been without effect in the right direction, and that the local authority has recently given a little more attention to the sanitary requirements of the town, which has been followed by a diminution of the death-roll.

The officer of health has been invested with a little more of that independent power of action which many think it desirable that he should possess, and a staff of assistants has been placed at his disposal to systematically inspect and report upon the various matters brought to their notice.

The disinfection of houses where diseases of a contagious nature have had their habitat is strictly enforced, and, with a view to suppressing overcrowding, houses wherein lodgers are taken are registered by the medical officer under the powers of the Sanitary Act; these houses, although not included amongst the class of common lodging-houses, are subject to similar rules and surveillance.

Within the last twelve months many miles of main sewers and drains have been laid down, and the work of levelling, flagging, and paving new streets progresses in a satisfactory manner. With this awakening to activity it is no matter of surprise that typhus fever and other diseases of a zymotic character should decrease, as the following table (which is a summary of all deaths from zymotics during the quarter ending May 26, 1866, and May 25, 1867), shows to be the case:—

Quarter ending May 26, 1866.	
Small-pox	19
Measles	62
Scarlatina	23
Hooping-cough	80
Croup	26
Diarrhœa	34
Dysentery	3
Typhus	162
Erysipelas	6
Syphilis	3
Diphtheria	6
Quinsy	3
Total	427

Quarter ending May 25, 1867.	
Small-pox	13
Measles	6
Scarlatina	20
Hooping-cough	52
Croup	19
Diarrhœa	21
Dysentery	2
Typhus	50
Erysipelas	3
Syphilis	2
Diphtheria	8
Quinsy	1
Total	197

The total number of deaths registered in the borough of Leeds during the thirteen weeks ending May 28, 1867, was 1,557, against 2113, the number that occurred during the corresponding period last year.

The deaths during the above quarter of the present year were at the rate of 26·7 per 1,000 per annum, against 36·8, the rate that prevailed during the relative time last year.

This recent improvement although most marked during, was not confined to, last quarter, for the first ordinary quarter of the present year ending March 30th presented also a favourable contrast to the corresponding quarters of 1865 and 1866. The number of deaths registered during the first quarters of 1865, 1866, and 1867, being respectively 1,788, 2,095, and 1,700.

The above result furnishes a strong argument for earnest sanitarians to persevere in the good work of endeavouring to prevent unnecessary disease and death, and still vigilantly to guard the watch-tower from which public opinion makes itself felt and heard, for it would be idle to suppose that the foregoing description of some of the work achieved in Leeds is anything beyond the mere commencement of effort to be pursued in a large field of labour, and it must not be forgotten that the public mind still requires educating on common sanitary laws, and that the public attention still needs directing to the importance of building model houses for the poor, public abattoirs, mortuaries, &c.

DUNKELD.—Most of our readers will have tarried at this interesting town, who have passed it on their way to the Eastern Highlands of Scotland, and little would they dream that a spot so highly favoured by nature, should be so utterly degraded by man, as it would appear to be from the following extracts from a paper read by Dr. John Adamson, of St. Andrew's, before the Philosophical Institute of that city:—

"Dunkeld," he says, "is a town of Perthshire, situated on the north bank of the Tay, in the corner of an irregular natural amphitheatre, surrounded by hills varying in height from 1,000 to 1,500 feet. When this open space among the hills is estimated by the eye, it appears to be less than two miles at its greatest length, by half-a-mile in breadth; and viewed pictorially, it doubtless is a beautiful site for a small town. It is luxuriant with vegetation, and studded with wooded knolls and handsome villas, growing into a second town near the railway station. The river Tay passes through it, with grassy flats and fine old trees upon its banks; while the whole is enclosed within a background of woods and rocks and heather, rising high around it on picturesque-looking hills. The miniature town, too, when looked at in the same merely pictorial light from the middle of the bridge, or from the opposite river bank, is not unworthy of its site. It is a cluster of white-walled, blue-slated houses, nestled among trees beside its old cathedral church; and with the wooded hills behind, and the broad river flowing towards it through the green lawns and the graceful foliage of the Athole grounds, it exhibits, in a single view, a combination of scenic beauties in their kind which can rarely be equalled.

"But this town has another aspect in which there is no beauty. It is situated upon a level space of small area, between the river and a wooded hill, with trees encroaching upon the houses. The space towards the river is divided into back courts and narrow gardens, by walls and hedges. Streets stand at right angles to each other; and a few houses of more than one storey in height, are crowded into lanes and courts behind the streets. Drainage to the river is only partial; wells within the town indicate the absence of natural drainage; while the surface, composed of sandy gravel, is absorbent of fluids. Refuse of men and animals is allowed to accumulate within the town, in large offensive dunghills. In the warm month of September, pigs might be seen standing knee-deep in their own dung. Dirty liquids were stagnating in the sun in some of the narrow back courts, with other foul accumulations unnameable—nuisances alike to sight and smell.

"The air in Dunkeld is thus seen to be limited in extent, in consequence of the small area surface occupied by houses; and, in consequence of its sheltered site, the streets are screened from the wholesome breezes enjoyed by exposed towns. The ventilation of individual houses is impeded by the plan of the streets, and by trees; and while such a combination of impediments to free circulation and renewal of the air demands every precaution possible to preserve its purity, a want of proper police regulations permits slovenly dirty people to pollute it for themselves and their neighbours, by habits which, without exaggeration of language, may be termed a disgrace to a civilized society.

"In 1851 and 1861 the census returns for the Dunkeld district gave 1,141 and 1,080 as the numbers of the population in these years; and the total deaths, within the district from 1855 to 1861, a period of seven years, were 195, or 28 yearly—numbers which are equivalent to a death rate of 25·5 for the district.

"The inhabitants of the town, according to a competent local authority, were about 1,000 in 1851, but in 1861 this number had diminished to 926, while the deaths from 1855 to 1865, inclusive, were 265, or 24 1-11th yearly. If 950 be assumed as an average population for the eleven years—and it probably is above the actual number—the death rate for the town alone cannot be less than 25·5. It is 9·1 in excess of the rate in Grantown,* where the annual deaths among 1,500 living are actually fewer than among a thousand in Dunkeld; and it exhibits the strange and melancholy spectacle of a small agricultural community, occupying a beautiful Highland valley, who are not more healthy than if they were confined to the dingy courts and lanes of a large town."

If the author of the paper from which these extracts are made would add another obligation to that which he has conferred upon society, by publishing these facts, he would do well. Let him draw the attention of some spirited inhabitant of Dunkeld to the 49th Section of the Sanitary Act of 1866, and recommend him to forward a complaint of the disgraceful condition of the little place to the Home Office; we think we may safely predict that a visit from the Government Inspector would soon reduce the death rate.

* The author was comparing Dunkeld with Grantown in his paper.

Quarterly List of Publications received for Review.

1. The Elements of Natural Philosophy; or, an Introduction to the Study of the Physical Sciences. By Charles Brooke, M.A., F.R.S. Based on the Treatise by the late Dr. Golding Bird. Sixth Edition. 880 pp. Fcap. 8vo. 701 *Wood Engravings.* *John Churchill & Sons.*

2. Hospitals, Infirmaries, and Dispensaries: their Construction, Interior Arrangement, and Management, with Descriptions of existing Institutions and Remarks on the present System of affording Relief to the Sick Poor. By F. Oppert, M.D., L.R.C.P.L., Physician to the City Dispensary. 230 pp. Roy. 8vo. 58 *Wood Engravings.* *John Churchill & Sons.*

3. A Dictionary of Science, Literature, and Art. New edition by W. T. Brande, D.C.L., F.R.S., and Rev. Geo. W. Cox, M.A. 3 vols. 8vo. *Longmans & Co.*

4. Blind People: their Works and Ways; with Sketches of the Lives of some famous Blind Men. By Rev. B. G. Johns, M.A., Chaplain of the Blind School, St. George's Fields. *With Engravings.* 200 pp. Post 8vo. *John Murray.*

5. Light: its Influence on Life and Health. By Forbes Winslow, M.D., D.C.L. Oxon. (Hon.), &c. *Longmans & Co.*

6. The North-west Peninsula of Iceland: being the Journal of a Tour in Iceland in the Spring and Summer of 1862. By C. W. Shepherd, M.A., F.Z.S. 170 pp. Crown 8vo. *Longmans & Co.*

7. The Electric Telegraph. By Dr. Lardner. A new edition by Edw. B. Bright, F.R.A.S., Secretary of the British and Irish Magnetic Telegraph Company. 140 *Engravings.* 280 pp. Post 8vo. *James Walton.*

8. Handbook of Astronomy. By Dionysius Lardner, D.C.L. Third edition by Edwin Dunkin, F.R.A.S., Superintendent of the Altazimuth Department, Royal Observatory, Greenwich. 38 *Plates and* 109 *Wood Engravings.* 550 pp. Post 8vo. *James Walton.*

9. Memoirs, Annual Report, and Catalogues of the Geological Survey of India. *Calcutta.*

10. Transactions of the American Institute, New York.

11. Observations on the Genus Unio, &c., &c. By Isaac Lea, LL.D. 24 *Plates.* Roy. 4to. Vol. XI. *From the Author.*

12. Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartêt and Henry Christy. Edited by Thomas Rupert Jones, Professor of Geology, Royal Military College, Sandhurst. Part IV. *From the Executors of the late Henry Christy, Esq.*

PAMPHLETS, PERIODICALS, AND PROCEEDINGS OF SOCIETIES.

Sesion Pública Aniversario vigésimo-septimo del Instituto Médico Valenciano. *Valencia.*

Geology and Agriculture. By E. St. John Fairman, F.G.S. 8 pp. 8vo. *Florence.*

The Poisons of the Spreading Diseases. By Benjamin W. Richardson, M.D., F.R.C.P. 27 pp. 8vo. *J. Churchill & Sons.*

A Sheet of Instructions for the Prompt Treatment of Accidents and Emergencies. By A. Smee, F.R.S.

On the Encroachment of the Sea between the River Mersey and the Bristol Channel. Prize Essay. By J. E. Thomas, F.G.S. 20 pp. 8vo. *E. & F. N. Spon.*

Christianity and Rationalism in their Relations to Natural Science: being a Protest against certain Principles advocated in Mr. Lecky's History of the Rise and Influence of the Spirit of Rationalism in Europe. By Charles Daubeny, M.D., F.R.S., Professor of Botany in the University of Oxford. 24 pp. Demy 8vo. *James Parker & Co.*

Meteorological Observations on the Humidity of the Air of Scarborough, with Chapters on Rain, Rain Gauges, and Rainfall Investigations, and on the Humidity of the Atmosphere in Relation to Disease. By Cornelius B. Fox, M.D., M.R.C.P. Lond. 50 pp. Crown 8vo. *Simpkin & Co*

Experimental Investigations connected with the Supply of Water from the Hooghly to Calcutta. By David Waldie, F.C.S. 32 pp. 8vo.

On the Development and Succession of the Teeth in the Marsupialia. By William Henry Flower, F.R.S. 4 pp. 8vo.

Germinal Matter and the Contact Theory. By James Morris, M.D. Lond. 20 pp. Demy 8vo. *John Churchill & Sons.*

Clinical Lectures (illustrated by Coloured Photographs from Life) on the Diseases of the Skin. By B. Squire, M.B., F.L.S. Nos. 1 & 2. *John Churchill & Sons.*

Household Manuals. Good Food: What it is, and How to get it. By Edwin Lankester, M.D., F.R.S. *Routledge & Sons.*

An Explanation of the Popular Weather Prognostics of Scotland, on Scientific Principles. By the Rev. Charles Clouston. *Edinburgh: A. & C. Black.*

A new Chemical Nomenclature. By S. D. Tillman, A.M. *Albany: C. van Benthuysen & Sons.*

On the Distribution of Temperature in the Lower Region of the Earth's Atmosphere. By Henry Hennessy, F.R.S. *Dublin: M. H. Gill.*

On the Social Statistics of certain Boroughs and Townships in Lancashire and Cheshire during the last Twenty Years. By Henry Carne Oats, LL.B. *Manchester.*

The Doctrine of the Correlation of Forces: its Development and Evidence. By the Rev. James Cranbrook. *Edinburgh: Edmonston.*

A Comparison of the Death Rates of Grantown and Dunkeld. By John Adamson, M.D.

A New Theory of the Cause of Tides. By John Cuthbertson. *Glasgow: Murray & Son.*

On the Function of the Blood in Muscular Work. By C. W. Heaton, F.C.S.

Intercolonial Exhibition, 1866. Mining and Mineral Statistics. By R. Brough Smyth, F.G.S. *Melbourne: Blundell & Ford.*

Readwin's Index to Mineralogy. By T. A. Readwin, F.G.S. *London: Spon.*

The American Naturalist (a popular Illustrated Magazine of Natural History). Salem. Essex Institute. *London: Trübner.*

Revue Universelle des Mines, &c. *Paris and Liege.*

Bulletin Mensuel de la Société Impériale d'Acclimatation. *Paris.*

The Geological Magazine. *Trübner & Co.*

Le Mouvement Médical, Journal de la Santé publique.

The Canadian Naturalist and Geologist. *Montreal: Dawson Bros.*

The Scientific Journal. *Philadelphia.*

The Naturalist's Circular, Medium of Exchange and Amateur's Reporter, in Natural History, Geology, and Microscopy. June, 1867.

Journal of the Academy of Natural Sciences of Philadelphia. New Series. Vol. VI. Part 1.

Proceedings of the Academy of Natural Sciences of Philadelphia for the year 1866.

The President's Address and Reports for 1866, together with Rules, List of Members, and Catalogue of Books, of the West Kent Natural History, Microscopical, and Photographic Society. 20 pp. Fcap. 8vo.

The Proceedings of the Cotteswold Naturalists' Field Club for 1865. 74 pp. Royal 8vo.

Introductory Address at the Public Opening of the Medical Session 1866-67, in the University of Glasgow. By W. T. Gairdner, M.D., Professor of Practice of Physic in the University. 20 pp. 8vo. *Maclehose, Glasgow.*

Proceedings of the Bath Natural History and Antiquarian Field Club.

Proceedings of the Royal Institution of Great Britain.
" " Royal Society.
" " Royal Astronomical Society.
" " Royal Geographical Society.
" " Chemical Society.
" " Geological Society.
" " Zoological Society.

TO CORRESPONDENTS.

The Editors will be glad to receive the Printed Proceedings of Local Boards of Health, and of other Sanitary Corporations, to which due consideration will be given by the Editor of the Quarterly Article on the Public Health.

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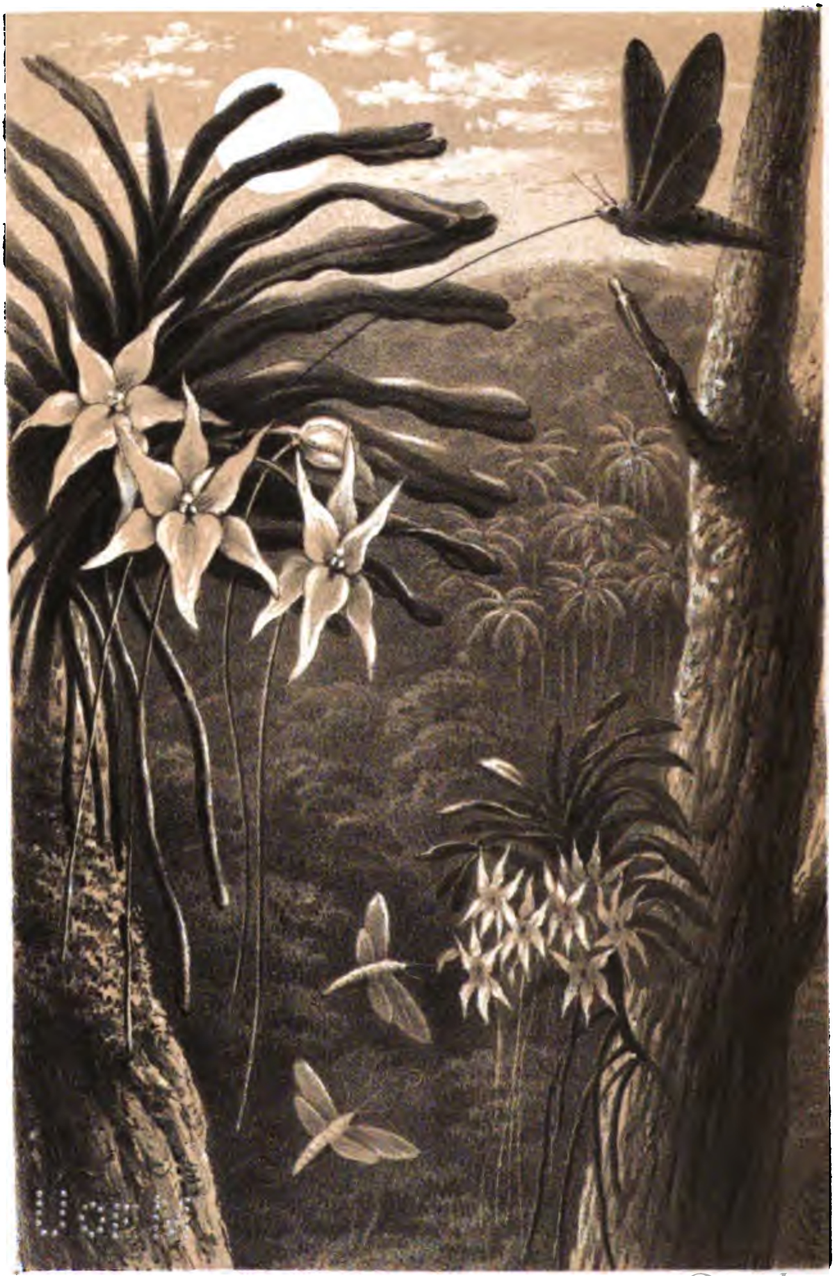

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SPHINX MOTH FERTILIZING ANGRŒCUM SESQUIPEDALE IN
THE FORESTS OF MADAGASCAR.

THE QUARTERLY
JOURNAL OF SCIENCE.
OCTOBER, 1867.

I. CREATION BY LAW.

By Alfred R. Wallace, F.Z.S., F.R.G.S., &c.

Among the various criticisms that have appeared on Mr. Darwin's celebrated "Origin of Species," there is, perhaps, none that will appeal to so large a number of well educated and intelligent persons as that contained in the Duke of Argyll's "Reign of Law." The noble author represents the feelings and expresses the ideas of that large class who take a keen interest in the progress of Science in general, and especially that of Natural History, but have never themselves studied nature in detail, or acquired that personal knowledge of the structure of closely allied forms,—the wonderful gradations from species to species and from group to group, and the infinite variety of the phenomena of "variation" in organic beings,—which are absolutely necessary for a full appreciation of the facts and reasonings contained in Mr. Darwin's great work.

Nearly half of the Duke's book is devoted to an exposition of his idea of 'Creation by Law,' and he expresses so clearly what are his difficulties and objections as regards the theory of "Natural Selection," that I think it advisable that they should be fairly answered, and that his own views should be shown to lead to conclusions as hard to accept as any which he imputes to Mr. Darwin.

The point on which the Duke of Argyll lays most stress is, that proofs of Mind everywhere meet us in Nature, and are more especially manifest wherever we find "contrivance" or "beauty." He maintains that this indicates the constant supervision and direct interference of the Creator, and cannot possibly be explained by the unassisted action of any combination of laws. Now Mr. Darwin's work has for its main object to show, that all the phenomena of living things,—all their wonderful organs and complicated structures, their infinite variety of form, size, and colour, their intricate and involved relations to each other,—may have been produced by the action of a few general laws of the simplest kind, laws which are in most cases mere statements of admitted facts. The chief of these laws or facts are the following:—

1. *The Law of Multiplication in Geometrical Progression.*—All organized beings have enormous powers of multiplication. Even man, who increases slower than all other animals, could under favourable circumstances double his numbers every ten years, or a thousand-fold in a century. Most animals and plants could increase their numbers from ten to a thousand-fold every year.

2. *The Law of Limited Population.*—The number of living individuals of each species in any country, or in the whole globe, is practically stationary; whence it follows that the whole of this enormous increase must die off almost as fast as produced, except only those individuals for whom room is made by the death of parents. As a simple but striking example, take an oak forest. Every oak will drop annually thousands or millions of acorns, but till an old tree falls, not one of these millions can grow up into a tree. They must die at various stages of growth.

3. *The Law of Heredity, or likeness of offspring to their parents.*—This is a universal, but not an absolute law. All creatures resemble their parents in a high degree, and in the majority of cases very accurately; so that even individual peculiarities of whatever kind in the parents are almost always transmitted to some of the offspring.

4. *The Law of Variation.*—This is fully expressed by the lines:—

> "No being on this earthly ball,
> Is like another, all in all."

Offspring resemble their parents very much, but not wholly—each being possesses its individuality. This "variation" itself varies in amount, but it is always present, not only in the whole being, but in every part of every being. Every organ, every character, every feeling is individual; that is to say, *varies* from the same organ, character, or feeling in every other individual.

5. *The Law of unceasing change of Physical Conditions upon the Surface of the Earth.*—Geology shows us that this change has always gone on in times past, and we also know that it is now everywhere going on.

6. *The Equilibrium of Nature.*—When a species is well adapted to the conditions which environ it,—it flourishes; when imperfectly adapted it decays; when ill-adapted it becomes extinct. If *all* the conditions which determine an organism's well-being are taken into consideration, this statement can hardly be disputed.

This series of facts or laws are mere statements of what is the condition of nature. They are facts or inferences which are generally known, generally admitted,—but in discussing the subject of the 'Origin of Species,'—as generally forgotten. It is from these universally admitted facts that the origin of all the varied forms of nature may be deduced by a logical chain of reasoning, which, however, is at every step verified and shown to be in strict accord with facts; and, at the same time, a host of curious facts which can by no other means be understood, are explained and accounted for. It is probable that these primary facts or laws are but results of the very nature of life, and of the essential properties of organized and unorganized matter. Mr. Herbert Spencer, in his "First Principles" and his "Biology" has, I think, made us able to understand how this may be; but at present we may accept these laws without going further back, and the question then is—whether the variety, the harmony, the contrivance, and the beauty we perceive in organic beings, can have been produced by the action of these laws alone, or whether we are required to believe in the incessant interference and direct action of the mind and will of the Creator. It is simply a question of how the Creator has worked. The Duke maintains, that he has personally applied general laws to produce effects which those laws are not in themselves capable of producing; that the universe alone, with all its laws intact, would be a sort of chaos, without variety, without harmony, without design, without beauty; that there is not (and therefore we may presume that there could not be) any self-developing power in the universe. I believe, on the contrary, that the universe is so constituted as to be self-regulating; that as long as it contains Life, the forms under which that life is manifested have an inherent power of adjustment to each other and to surrounding nature; and that this adjustment necessarily leads to the greatest possible amount of variety and beauty and enjoyment, because it does depend on general laws, and not on a continual supervision and re-arrangement of details. As a matter of feeling and religion, I hold this to be a far higher conception of the Creator and of the Universe than that which I must call the "continual interference," hypothesis; but it is not a question to be decided by our feelings or convictions, it is a question of facts and of reason. Could the change, which Geology shows us has ever taken place in the forms of life, have been produced by general laws, or does it imperatively require the incessant supervision of a creative mind? This is the question for us to consider, and our opponents have the difficult task of proving their negative, if we show that there are both facts and analogies in our favour.

Mr. Darwin has laid himself open to much misconception, and has given to his opponents a powerful weapon by his continual use of metaphor in describing the wonderful co-adaptations of organic beings.

"It is curious," says the Duke of Argyll, "to observe the language which this most advanced disciple of pure naturalism instinctively uses, when he has to describe the complicated structure of this curious order of plants (the Orchids). 'Caution in ascribing intentions to nature,' does not seem to occur to him as possible. Intention is the one thing which he does see, and which when he does not see, he seeks for diligently until he finds it. He exhausts every form of words and of illustration by which intention or mental purpose can be described. 'Contrivance'—'curious contrivance'—'beautiful contrivance,'—these are expressions which occur over and over again. Here is one sentence describing the parts of a particular species; 'the Labellum is developed into a long nectary, *in order* to attract Lepidoptera, and we shall presently give reason for suspecting that the nectar is *purposely* so lodged, that it can be sucked only slowly *in order* to give time for the curious chemical quality of the viscid matter setting hard and dry.'" Many other examples of similar expressions are quoted by the Duke, who maintains that no explanation of these "contrivances" has been or can be given, except on the supposition of a personal contriver, specially arranging the details of each case, although causing them to be produced by the ordinary processes of growth and reproduction.

Now there is a difficulty in this view of the origin of the structure of Orchids which the Duke does not allude to. The majority of flowering plants are fertilized, either without the agency of insects or, when insects are required, without any very important modification of the structure of the flower. It is evident, therefore, that flowers might have been formed as varied, fantastic, and beautiful as the Orchids and yet have been fertilized by insects, in the same manner as Violets, or Clover, or Primroses or a thousand other flowers. The strange springs and traps and pitfalls found in the flowers of Orchids cannot be necessary *per se*, since exactly the same end is gained in ten thousand other flowers which do not possess them. Is it not then an extraordinary idea to imagine the Creator of the Universe *contriving* the various complicated parts of these flowers as a mechanic might contrive an ingenious toy or a difficult puzzle? Is it not a more worthy conception that they are some of the results of those general laws which were so co-ordinated at the first introduction of life upon the earth as to result necessarily in the utmost possible development of varied forms?

But let us take one of the simpler cases adduced and see if our general laws are unable to account for it.

"There is a Madagascar Orchis—the Angræcum sesquipedale—with an immensely long and deep nectary. How did such an extraordinary organ come to be developed? Mr. Darwin's explanation is this. The pollen of this flower can only be removed by the proboscis of some very large moths trying to get at the nectar at the bottom of the vessel. The moths with the longest proboscis would do this most effectually; they would be rewarded for their long noses by getting the most nectar; whilst on the other hand, the flowers with the deepest nectaries would be the best fertilized by the largest moths preferring them. Consequently, the deepest nectaried Orchids and the longest nosed moths would each confer on the other a great advantage in the 'battle of life.' This would tend to their respective perpetuation and to the constant lengthening of nectar and noses." The Duke of Argyll then quotes Darwin's diffident statement "that we can thus *partially* understand how this astonishing nectary was produced," and says it is indeed but a *partial* understanding,—but he does not show what point the explanation given fails to meet. I maintain, on the contrary, that the laws of multiplication, variation, and survival of the fittest, already referred to, would under certain conditions *necessarily* lead to the production of this extraordinary nectary. Let it be remembered that what we have to account for is only the unusual length of this organ. A nectary is found in many orders of plants and is especially common in the Orchids, but in this one case only is it more than a foot long. How did this arise? We begin with the fact, proved experimentally by Mr. Darwin, that moths do visit Orchids, do thrust their spiral trunks into the nectaries, and do fertilize them by carrying the pollinia of one flower to the stigma of another. He has further explained the exact mechanism by which this is effected, and the Duke of Argyll admits the accuracy of his observations. In our British species, such as Orchis pyramidalis, it is not necessary that there should be any exact adjustment between the length of the nectary and that of the proboscis of the insect, and thus a number of insects of various sizes are found to carry away the pollinia and aid in the fertilization. In the Angræcum sesquipedale, however, it is necessary that the proboscis should be forced down into a particular part of the flower, and this would only be done by a large moth straining to drain the nectar from the bottom of the long tube.* Now let us start from the time when the nectary was only half its present length or about six inches, and was chiefly fertilized by a species of moth which appeared at the time of the plant's flowering, and whose proboscis was of the same length. Among the millions of flowers of the Angræcum produced every year some would always be shorter than the average, some longer. The former, owing to the structure of the flower, would not get fertilized, because the moths could get all the nectar without forcing their trunks down to the very base.

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* It is a peculiarity of this species that the nectar only occupies a depth of one or two inches at the bottom of the nectary.

The latter would be well fertilized, and the longest would on the average be the best fertilized of all. By this process alone the average length of the nectary would annually increase, because, the short ones being sterile and the long ones having abundant offspring, exactly the same effect would be produced as if a gardener destroyed the short ones and sowed the seed of the long ones only; and this we know by experience would produce a regular increase of length, since it is this very process which has increased the size and changed the form of our cultivated fruits and flowers.

But this would lead in time to such an increased length of the nectary that many of the moths could only just reach the surface of the nectar, and only the few with exceptionally long trunks be able to suck up a considerable portion.

This would cause many moths to neglect these flowers because they could not get a satisfying supply of nectar, and if these were the only moths in the country the flowers would undoubtedly suffer and the further growth of the nectary be checked by exactly the same process which had led to its increase. But there are an immense variety of moths of various lengths of proboscis, and as the nectary became longer other and larger species would become the fertilizers, and would carry on the process till the largest moths became the sole agents. Now, if not before, the moth would also be affected, for those with the longest probosces would get most food, would be the strongest and most vigorous, would visit and fertilize the greatest number of flowers, and would leave the largest number of descendants. The flowers most completely fertilized by these moths being those which had the longest nectaries, there would in each generation be on the average an increase in the length of the nectaries, and also an average increase in the length of the proboscis of the moths, and this would be a *necessary result* from the fact that nature ever fluctuates about a mean, or that in every generation there would be flowers with longer and shorter nectaries, and moths with longer and shorter probosces than the average. No doubt there are a hundred causes that might have checked this process before it had reached the point of development at which we find it. If, for instance, the variation in the quantity of nectar had been at any stage greater than the variation in the length of the nectary, then smaller moths could have reached it and have effected the fertilization. Or if the growth of the probosces of the moths had from other causes increased quicker than that of the nectary, or if the increased length of proboscis had been injurious to them in any way, or if the species of moth with the longest proboscis had become much diminished by some enemy or other unfavourable conditions, then in any of these cases the shorter nectaried flowers which would have attracted and could have been fertilized by the smaller kinds of moths would have had the advantage. And checks of a similar nature to these no doubt have acted in other parts of the world, and have prevented such an extraordinary development of nectary as has been produced by favourable conditions in Madagascar only and in one single species of Orchid. I may here mention that some of the large Sphinx moths of the tropics have probosces nearly as long as the nectary of Angræcum sesquipedale.* Now, instead of this beautiful self-acting adjustment, the Duke of Argyll's theory is, that the Creator of the Universe by a direct act of his Almighty power so disposed the natural forces influencing the growth of this one species of plant as to cause its nectary to increase to this enormous length, and at the same time by an equally special act determined the flow of nourishment in the organization of the moth so as to cause its proboscis to increase in exactly the same proportion, having previously so constructed the Angræcum that it could only be maintained in existence by the agency of this moth. But what proof is given or suggested that this was the mode by which the adjustment took place? None whatever, except a feeling that there is an adjustment of a delicate kind and an inability to see how known causes could have produced such an adjustment. I believe I have shown, however, that such an adjustment is not only possible but inevitable, unless at some point or other we deny the action of those simple laws which we have already admitted to be expressions of existing facts.

It is difficult to find anything like parallel cases in inorganic nature, but that of a river may perhaps illustrate the subject in some degree. Let us suppose a person totally ignorant of Modern Geology to study carefully a great River System. He finds in the lower part a deep broad channel filled to the brim, flowing slowly through a flat country and carrying out to the sea a quantity of fine sediment. Higher up it branches into a number of smaller channels flowing alternately through flat valleys and between high banks; sometimes he finds a deep rocky bed with perpendicular walls carrying the water through a chain of hills; where the stream is narrow he finds it deep, where wide shallow. Further up still he comes to a mountainous region with hundreds of streams and rivulets each with its tributary rills and gullies collecting the water from every square mile of surface, and every channel adapted to the water that it has to carry. He finds that the bed of every branch and stream and rivulet has a steeper and steeper slope as it approaches its sources, and is thus enabled to carry off the water from heavy rains and to bear away the stones and pebbles and gravel that would otherwise block up its course. In every part of this system he would see exact adaptation of means to an end. He would say, that this system of channels must have been designed, it answers its purpose so effectually. Nothing but a mind could have so exactly adapted the slopes of the channels, their capacity, and frequency to the nature of the soil and the quantity of the rainfall. Again, he would see special adaptation to the wants of man in broad quiet navigable rivers through fertile alluvial plains that would support a large population, while the rocky streams and mountain torrents were confined to those sterile regions suitable only for a small population of shepherds and herdsmen. He would listen with incredulity to the Geologist who assured him that the adaptation and adjustment he so admired was an inevitable result of the action of general laws. That the rains and rivers, aided by subterranean forces, had modelled the country, had formed the hills and valleys, had scooped out the river beds and levelled the plains;—and it would only be after much patient observation and study, after having watched the minute changes produced year by year and multiplying them by thousands and ten thousands, after visiting the various regions of the earth and seeing the changes everywhere going on, and the unmistakeable signs of greater changes in past times,—that he could be made to understand that the surface of the earth, however beautiful and harmonious it may appear, is strictly due in every detail to the action of forces which are demonstrably self-adjusting.

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* I have carefully measured the proboscis of a specimen of *Macrosila cluentius* from South America in the collection of the British Museum, and find it to be nine inches and a quarter long! One from tropical Africa (*Macrosila morganii*) is seven inches and a half. A species having a proboscis two or three inches longer could reach the nectar in the largest flowers of *Angræcum sesquipedale*, whose nectaries vary in length from ten to fourteen inches. That such a moth exists in Madagascar may be safely predicted; and naturalists who visit that island should search for it with as much confidence as astronomers searched for the planet Neptune,—and they will be equally successful!

Moreover, when he had sufficiently extended his inquiries, he would find that every evil effect which he would imagine must be the result of non-adjustment does somewhere or other occur, only it is not always evil. Looking on a fertile valley he would say—"If the channel of this river was not well adjusted, if for a few miles it sloped the wrong way, the water could not escape, and all this fertile valley full of human beings would become a waste of waters." Well, there are hundreds of such cases. Every lake is a valley "wasted by water," and in some cases (as the Dead Sea) it is a positive evil, a blot upon the harmony and adaptation of the surface of the earth. Again, he might say—"If rain did not fall here, but the clouds passed over us to some other regions, this fair valley would be a desert." And there are such deserts over a large part of the earth, which abundant rains would convert into pleasant dwelling-places for man. Or he might observe some great navigable river, and reflect how easily rocks or a steeper channel in places might render it useless to man;—and a little inquiry would show him hundreds of rivers in every part of the world which are thus rendered useless for navigation.

Exactly the same thing occurs in organic nature. We see some one wonderful case of adjustment, some unusual development of an organ, but we pass over the hundreds of cases in which that adjustment and development do not occur. No doubt when one adjustment is absent another takes its place, because no organism can continue to exist that is not adjusted to its environment; and unceasing variation with unlimited powers of multiplication, in most cases, furnish the means of self-adjustment. The world is so constituted, that by the action of general laws there is produced the greatest possible variety of surface and of climate; and by the action of laws equally general, the greatest possible variety of organisms have been produced adapted to the varied conditions of every part of the earth. The Duke of Argyll would probably himself admit that the varied surface of the earth, the plains and valleys, the hills and mountains, the deserts and volcanoes, the winds and currents, the seas and lakes and rivers, and the various climates of the earth, are all the results of general laws acting and re-acting during countless ages; and that the Creator does not appear to guide and control the action of these laws — here determining the height of a mountain, there altering the channel of a river—here making the rains more abundant, there changing the direction of a current. He would probably admit that the forces of inorganic nature are self-adjusting, and that the result necessarily fluctuates about a given mean condition (which is itself slowly changing), while within certain limits the greatest possible amount of variety is produced. If then a "contriving mind" is not necessary at every step of the process of change eternally going on in the inorganic world. why are we required to believe in the continual action of such a mind in the region of organic nature? True, the laws at work are more complex, the adjustments more delicate, the appearance of special adaptation more remarkable; but why should we measure the creative mind by our own? Why should we suppose the machine too complicated to have been designed by the Creator so complete, that it would necessarily work out harmonious results? The theory of "continual interference" is a limitation of the Creator's power. It assumes that he could not work by pure law in the organic as he has done in the inorganic world; it assumes that he could not foresee the consequences of the laws of matter and mind combined—that results would continually arise which are contrary to what is best, and that he has to change what would otherwise be the course of nature in order to produce that beauty and variety and harmony, which even we, with our limited intellects, can conceive to be the result of self-adjustment in a universe governed by unvarying law. If we could not conceive the world of nature to be self-adjusting and capable of endless development, it would even then be an unworthy idea of a Creator to impute the incapacity of our minds to him; but when many human minds can conceive and can even trace out in detail some of the adaptations in nature as the necessary results of unvarying law, it seems strange that in the interests of religion any one should seek to prove that the System of Nature instead of being above, is far below our highest conceptions of it. I, for one, cannot believe that the world would come to chaos if left to Law alone. I cannot believe that there is in it no inherent power of developing beauty or variety, and that the direct action of the Deity is required to produce each spot or streak on every insect, each detail of structure in every one of the millions of organisms that live or have lived upon the earth. For it is impossible to draw a line. If any modifications of structure could be the result of law, why not all? If some self-adaptations could arise, why not others? If any varieties of colour, why not all the variety we see? No attempt is made to explain this except by reference to the fact that "purpose" and "contrivance" are everywhere visible, and by the illogical deduction that they could only have arisen from the direct action of some mind, because the direct action of our minds produces similar "contrivances;" but it is forgotten that adaptation, however produced, must have the appearance of design. The channel of a river looks as if made *for* the river although it is made *by* it; the fine layers and beds in a deposit of sand often look as if they had been sorted and sifted and levelled designedly; the sides and angles of a crystal exactly resemble similar forms designed by man; but we do not therefore conclude that these effects have, in each individual case, required the directing action of a creative mind, or see any difficulty in their being produced by natural Law.

Let us, however, leave this general argument for a while, and turn to another special case which our author appeals to as conclusive against Mr. Darwin's views. "Beauty" is as great a stumbling-block to the Duke of Argyll as "contrivance." He cannot conceive a system of the Universe so perfect as necessarily to develope every form of Beauty, but supposes that when anything specially beautiful occurs, it is a step beyond what that system could have produced, something which the Creator has added for his own delectation.

Speaking of the Humming Birds, the Duke of Argyll says: "In the first place, it is to be observed of the whole group that there is no connection which can be traced or conceived between the splendour of the humming birds and any function essential to their life. If there were any such connection, that splendour could not be confined, as it almost exclusively is, to only one sex. The female birds are of course not placed at any disadvantage in the struggle for existence by their more sombre colouring." And after describing the various ornaments of these birds, he says: "Mere ornament and variety of form, and these for their own sake, is the only principle or rule with reference to which Creative Power seems to have worked in these wonderful and beautiful birds. . . . . . . A crest of topaz is no better in the struggle for existence than a crest of sapphire. A frill ending in spangles of the emerald is no better in the battle of life than a frill ending in spangles of the ruby. A tail is not affected for the purposes of flight, whether its marginal or its central feathers are decorated with white. . . . . Mere beauty and mere variety for their own sake, are objects which we ourselves seek when we can make the Forces of Nature subordinate to the attainment of them. There seems to be no conceivable reason why we should doubt or question that these are ends and aims also in the forms given to living organisms."*

Here the statement that "no connection can be conceived between the splendour of the humming birds and any function essential to their life;" is met by the fact that Mr. Darwin has not only conceived but has shown, both by observation and reasoning, how beauty of colour and form may have a direct influence on the most important of all the functions of life, that of reproduction. In the variations to which birds are subject, any more brilliant colour than usual would be attractive to the females, and would lead to the individuals so adorned leaving more than the average number of offspring. Experiment and observation have shown that this kind of sexual selection does actually take place, and the laws of inheritance would necessarily lead to the further development of any individual peculiarity that was attractive, and thus the splendour of the humming birds is directly connected with their very existence. It is true that "a crest of topaz may be no better than a crest of sapphire," but either of these may be much better than no crest at all; and the different conditions under which the parent form must have existed in different parts of its range, will have determined different variations of tint, either of which were advantageous. The reason why female birds are not adorned with equally brilliant plumes is sufficiently clear; they would be injurious by rendering their possessors too conspicuous during incubation. Survival of the fittest has therefore favoured the development of those dark green tints on the upper surface of so many female humming birds, which are most conducive to their protection while the important functions of hatching and rearing the young are being carried on. Keeping in mind the laws of multiplication, variation, and survival of the fittest which are for ever in action, these varied developments of beauty and harmonious adjustments to conditions, are not only conceivable but demonstrable results.

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* 'Reign of Law,' p. 248.

The Duke's argument is solely founded on the supposed analogy of the Creator's mind to ours as regards the love of Beauty for its own sake; but if this analogy is to be trusted, then there ought to be no natural objects which are disagreeable or ungraceful in our eyes. And yet it is undoubtedly the fact that there are many such. Just as surely as the Horse and Deer are beautiful and graceful, the Elephant, Rhinoceros, and Camel are the reverse. The majority of Monkeys and Apes are not beautiful; the majority of Birds have no beauty of colour; a vast number of Insects and Reptiles are positively ugly. Now, if the Creator's mind is like ours, whence this ugliness? It is useless to say "that is a mystery we cannot explain," because we have attempted to explain one-half of creation by a method that will not apply to the other half. We know that a man with the highest taste and with unlimited wealth practically does abolish all ungraceful and disagreeable forms and colours from his own domains. If the beauty of creation is to be explained by the Creator's love of beauty, we are bound to ask why he has not banished deformity from the earth, as the wealthy and enlightened man does from his estate; and if we can get no satisfactory answer, we shall do well to reject the explanation offered. Again, in the case of flowers, which are always especially referred to as the surest evidence of beauty being an end of itself in creation, the whole of the facts are never fairly met. At least half the plants in the world have not bright-coloured or beautiful flowers, and Mr. Darwin has lately arrived at the wonderful generalization that flowers have become beautiful solely to attract insects to assist in their fertilization. He adds, "I have come to this conclusion from finding it an invariable rule that when a flower is fertilized by the wind it never has a gaily-coloured corolla."* Here is a most wonderful case of beauty being *useful* when it might be least expected. But much more is proved; for when beauty is of no use to the plant it is not given. It cannot be imagined to do any harm. It is simply not necessary, and is therefore withheld! We ought surely to have been told how this fact is consistent with beauty being "an end in itself," and with the statement of its being given to natural objects "for its own sake."

Let us now consider another of the Duke's objections which he thus sets forth:—

"Mr. Darwin does not pretend to have discovered any law or rule according to which new Forms have been born from old Forms. He does not hold that outward conditions, however changed, are sufficient to account for them. . . . . . . His theory seems to be far better than a mere theory—to be an established scientific truth—in so far as it accounts, in part at least, for the success and establishment and spread of new Forms *when they have arisen.* But it does not even suggest the law under which, or by or according to which, such new Forms are introduced. Natural Selection can do nothing, except with the materials presented to its hands. It cannot select except among the things open to selection. . . . Strictly speaking, therefore, Mr. Darwin's theory is not a theory on the Origin of Species at all, but only a theory on the causes which lead to the relative success or failure of such new forms as may be born into the world."*

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* 'Origin of Species,' 4th ed., p. 239.

In this and many other passages in his work the Duke of Argyll sets forth his idea of Creation as a "Creation by birth," but maintains that each birth of a new form from parents differing from itself, has been produced by a special interference of the Creator in order to direct the process of development into certain channels; that each new species is in fact a "special creation," although brought into existence through the ordinary laws of reproduction. He maintains therefore that the laws of multiplication and variation cannot furnish the right kinds of materials at the right times for natural selection to work on. I believe that it can be logically proved from the six axiomatic laws before laid down, that such materials would be furnished; but I prefer to show that there are abundance of *facts* which prove the same thing.

The experience of all cultivators of plants and breeders of animals shows, that when a sufficient number of individuals are produced variations of any required kind can always be met with. On this depends the possibility of obtaining breeds, races, and fixed varieties of animals and plants, and it is found that any one form of variation may be accumulated by selection without materially affecting the other characters of the species; each *seems* to vary in the one required direction only. For example, in turnips, radishes, potatoes, and carrots, the root or tuber varies in size, colour, form, and flavour, while the foliage and flowers seem to remain almost stationary; in the cabbage and lettuce, on the contrary, the foliage can be modified into various forms and modes of growth, the root, flower, and fruit remaining little altered; in the cauliflower and brocoli the flower heads vary; in the garden pea the pod only changes. We get innumerable forms of fruit in the apple and pear, while the leaves and flowers remain undistinguishable; the same occurs in the gooseberry and garden currant. Directly however (in the very same genus) we want the flower to vary in the Ribes sanguineum, it does so, although mere cultivation for hundreds of years has not produced marked differences in the flowers of Ribes grossularia. When fashion demands any particular change in the form, or size, or colour of a flower, sufficient variation always occurs in the right direction, as is shown by our roses, auriculas, and geraniums; when, as recently, ornamental leaves come into fashion sufficient variation is found to meet the demand, and we have zoned pelargoniums and variegated ivy, and it is discovered that a host of our commonest shrubs and herbaceous plants have taken to vary in this direction just when we want them to do so! This rapid variation is not confined to old and well-known plants subjected for a long series of generations to cultivation, but the Sikhim Rhododendrons, the Fuchsias and Calceolarias from the Andes, and the Pelargoniums from the Cape are equally accommodating, and vary just when and where and how we require them.

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* 'Reign of Law,' p. 230.

Turning to animals we find equally striking examples. If we want any special quality in any animal we have only to breed it in sufficient quantities and watch carefully, and the required variety is *always* found and can be increased to almost any desired extent. In Sheep we get flesh, fat, and wool; in Cows, milk; in Horses, colour, strength, size and speed; in Poultry, we have got almost any variety of colour, curious modifications of plumage, and the capacity of perpetual egg-laying. In Pigeons we have a still more remarkable proof of the universality of variation, for it has been at one time or another the fancy of breeders to change the form of every part of these birds, and they have never found the required variations absent. The form, size, and shape of bill and feet, have been changed to such a degree as is found only in distinct genera of wild birds; the number of tail feathers has been increased, a character which is generally one of the most permanent nature and is of high importance in the classification of birds; and the size, the colour, and the habits have been also changed to a marvellous extent. In Dogs, the degree of modification and the facility with which it is effected is almost equally apparent. Look at the constant amount of variation in opposite directions that must have been going on to develope the poodle and the greyhound from the same original stock! Instincts, habits, intelligence, size, speed, form, and colour, have always varied as needed to produce the races which the wants or fancies or passions of men may have led them to desire. Whether they wanted a bull-dog to torture another animal, a greyhound to catch a hare, or a bloodhound to hunt down their oppressed fellow-creatures, the required variations have always appeared.

Now this great mass of facts, of which a mere sketch has been here given, are fully accounted for by the "Law of Variation" as laid down at the commencement of this paper. Universal variability,—small in amount but in every direction, ever fluctuating about a mean condition until made to advance in a given direction by "selection" natural or artificial,—is the simple basis for the indefinite modification of the forms of life;—partial, unbalanced, and consequently unstable modifications being produced by man, while those developed under the unrestrained action of natural laws, are at every step self-adjusted to external conditions by the dying out of all unadjusted forms, and are therefore stable and comparatively permanent. To be consistent in his views the Duke of Argyll must maintain that every one of the variations that have rendered possible the changes produced by man, have been determined at the right time and place by the will of the Creator. Every race produced by the florist or the breeder, the dog or the pigeon fancier, the ratcatcher, the sporting man, or the slave-hunter, must have been provided for by varieties occurring when wanted, and as these variations were never withheld it would appear as if the sanction of an allwise and all-powerful Being had been given to that which the highest human minds consider to be trivial, mean, or debasing.

This appears to be a complete answer to the theory, that variation sufficient in amount to be accumulated in a given direction must be the direct act of the creative mind, but it is also sufficiently condemned by being so entirely unnecessary. The facility with which man obtains new races, depends chiefly upon the number of individuals he can procure to select from. When hundreds of florists or breeders are all aiming at the same object the work of change goes on rapidly. But a common species in nature contains a thousandfold more individuals than any domestic race, and survival of the fittest must unerringly preserve all that vary in the right direction not only in obvious characters but in minute details, not only in external but in internal organs; so that if the materials are sufficient for the needs of man, there can be no want of them to fulfil the grand purpose of keeping up a supply of modified organisms exactly adapted to the changed conditions that are always occurring in the inorganic world.

Having now, I believe, fairly answered the chief objections of the Duke of Argyll, I proceed to notice one or two of those adduced in an able and argumentative essay on the "Origin of Species" in the July number of the 'North British Review.' The writer first attempts to prove that there are strict limits to variation. When we begin to select variations in any one direction, the process is comparatively rapid, but after a considerable amount of change has been effected it becomes slower and slower till at length its limits are reached, and no care in breeding and selection can produce any further advance. The race-horse is chosen as an example. It is admitted that, with any ordinary lot of horses to begin with, careful selection would in a few years make a great improvement, and in a comparatively short time the standard of our best racers might be reached. But that standard has not for many years been materially raised, although unlimited wealth and energy are expended in the attempt. This is held to prove that there are definite limits to variation in any special direction, and that we have no reason to suppose that mere time, and the selective process being carried on by natural law, could make any material difference. But the writer does not perceive that this argument fails to meet the real question, which is, not whether indefinite and unlimited change in any or all directions is possible, but whether such differences as do occur in nature could have been produced by the accumulation of variations by selection. In the matter of speed a limit of a definite kind as regards land animals does exist in nature. All the swiftest animals —deer, antelopes, hares, foxes, lions, leopards, horses, zebras, and many others, have reached very nearly the same degree of speed. Although the swiftest of each must have been for ages preserved, and the slowest must have perished, we have no reason to believe there is any advance of speed. The possible limits under existing conditions, and perhaps under possible terrestrial conditions, has been long ago reached. In cases, however, where this limit had not been so nearly reached as in the horse, we have been enabled to make a more marked advance and to produce a greater difference of form. The wild dog is an animal that hunts much in company, and trusts more to endurance than to speed. Man has produced the greyhound, which differs much more from the wolf or the dingo than the racer does from the wild Arabian.

Again, it is objected that the Pouter or the Fan-tail pigeon cannot be further developed in the same direction. Variation seems to have reached its limits in these birds. But so it has in nature. The Fan-tail has not only more tail feathers than any of the three hundred and forty existing species of pigeons, but more than any of the eight thousand known species of birds. There is, of course, some limit to the number of feathers of which a tail useful for flight can consist, and in the Fan-tail we have probably reached that limit. Many birds have the œsophagus or the skin of the neck more or less dilatable, but in no known bird is it so dilatable as in the Pouter pigeon. Here again the possible limit, compatible with a healthy existence, has probably been reached. In like manner the differences in the size and form of the beak in the various breeds of the domestic Pigeon, is greater than that between the extreme forms of beak in the various genera and subfamilies of the whole Pigeon tribe. From these facts, and many others of the same nature, we may fairly infer, that if rigid selection were applied to any organ, we could in a comparatively short time produce a much greater amount of change than that which occurs between species and species in a state of nature, since the differences which we do produce are often comparable with those which exist between distinct genera or distinct families. The facts adduced by the writer of this article, of the definite limits to variability in certain directions in domesticated animals, are no objection whatever to the view that all the modifications which exist in nature have been produced by the accumulation by natural selection of small and useful variations, since those very modifications have equally definite and very similar limits.

To another of this writer's objections—that by Professor Thomson's calculations the sun can only have existed in a solid state 500 millions of years, and that therefore *time* would not suffice for the slow process of development of all living organisms—it is hardly necessary to reply, as it cannot be seriously contended, either that this calculation has any claims to even approximate accuracy, or that the process of change and development may not have been sufficiently rapid to have occurred within that period. His objection to the Classification argument is, however, more plausible. The uncertainty of opinion among Naturalists as to which are species and which varieties, is one of Mr. Darwin's very strong arguments that these two names cannot belong to things quite distinct in nature and origin. The Reviewer says that this argument is of no weight, because the works of man present exactly the same phenomena, and he instances patent inventions, and the excessive difficulty of determining whether they are new or old. I accept the analogy, and maintain that it is all in favour of Mr. Darwin's views. For are not all inventions of the same kind directly affiliated to a common ancestor. Are not improved Steam Engines or Clocks the lineal descendants of some existing Steam Engine or Clock? Is there ever a new Creation in Art or Science any more than in Nature? Did ever patentee absolutely originate any complete and entire invention, no portion of which was derived from anything that had been made or described before? It is therefore clear that the difficulty of distinguishing the various classes of inventions which claim to be new is of the same nature as the difficulty of distinguishing varieties and species, because neither are absolute new creations, but both are alike descendants of pre-existing forms, from which and from each other they differ by varying and often imperceptible degrees. It appears then, that however plausible this writer's objections may seem, whenever he descends from generalities to any specific statement, his supposed difficulties turn out to be in reality strongly confirmatory of Mr. Darwin's view.

I cannot conclude this paper without expressing my admiration of the manner in which many subjects are treated in the "Reign of Law." With the definition and limitation of the term "Supernatural," I cordially agree. The exposition of the mechanism of flight is in every respect admirable; and the views on the Political and Social aspects of the Free Labour question are calculated to do much good, and to draw attention to a subject of the highest importance. The want of equal success in treating the question of the Origin of Species, is no doubt due to the excessively varied and complex nature of the phenomena presented by organized beings. Fully to grasp what is involved in that question demands a knowledge of details, which it requires years of study to amass; and without such knowledge the acutest and most comprehensive intellect will not suffice to solve so intricate a problem.

II. INTERNATIONAL EXHIBITIONS.

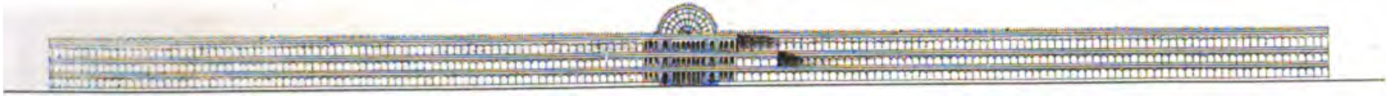
By Fred. Chas. Danvers, M.S.E.

At the close of another grand International Exhibition we may well pause for a while and consider how far these great displays of the works of industry have fulfilled the objects for which they were first established. The thirteenth Paris Industrial Exhibition, and the second International collection of works of art and industry which has been held in that city, is now within a few days of its termination; and we may, therefore, for all practical purposes, speak of it as a thing of the past. Whatever articles of exhibition it may have contained that were considered especially deserving of remark have long since been reported on, and the Exhibitors have been awarded such prizes as the respective juries have thought fit to recommend. The building will yet remain open for a short time longer, and then the work of removal and demolition will speedily commence.

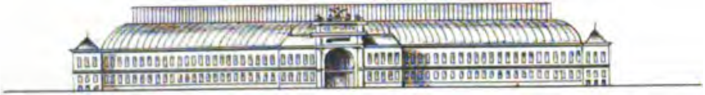
Before making any special allusion to the Paris Exhibition, it is our present intention to take a hasty glance at the origin and growth of Exhibitions generally, and the measures which preceded the first International Exhibition. We are indebted for much of our information on this subject to a Report on the Paris Exhibition, drawn up for the Society of Arts by M. Digby Wyatt, Esq., in 1849; and, with reference to Exhibitions in England, to the Official Catalogue of the International Exhibition of London, published in 1862.

Industrial Exhibitions in their early youth may have been content with a pedlar's pack, the travelling show-van, or a booth at a fair; but as soon as they gave up their gipsy life they began as national displays. It was long before the growing free-trade spirit of the age allowed them to become international, although museums did occasionally dabble in the products of foreign industry, and a catalogue of curiosities exhibited at the public theatre of Leyden, in 1699, gives an amusing account of one of these early Exhibitions.

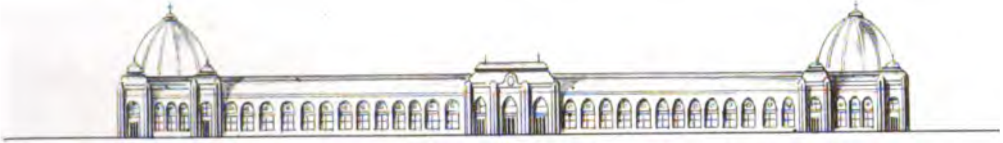
THE FOUR GREAT INTERNATIONAL EXHIBITIONS



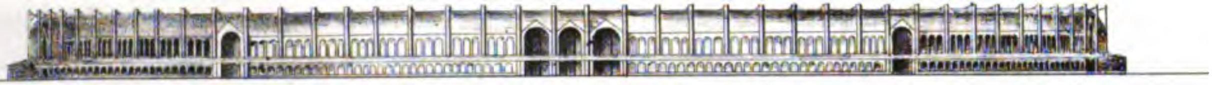
LONDON 1851.——AREA 18½ ACRES



PARIS 1855.——AREA 23¾ ACRES.

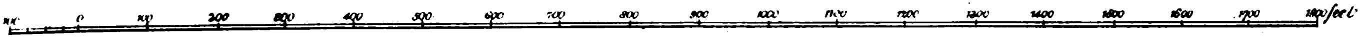


LONDON. 1862——AREA 24½ ACRES.



PARIS. 1867.——AREA 35 ACRES.

Scale.



F. G. Danvers, delᵗ

M. & N. Hanhart, lith.

In the fifth year of the French Republic (1797) the Marquis d'Avéze was requested by the Minister of the Interior to undertake the office of Commissioner to the Manufactures of the Gobelins (tapestries), of Sèvres (china), and of the Savonnerie (carpets). On visiting those establishments the marquis found the workshops deserted; for the artisans had been in a starving condition for two years, while the warehouses were full of the results of their labours. It then occurred to him that if these and other objects of industry could be collected together into one large Exhibition, a stimulus might be given to the native industry, and thus relief be afforded to the suffering workmen. This plan was approved by the Minister of the Interior, and the chateau of St. Cloud was appropriated to the purpose. Before the day fixed for public admission a number of distinguished persons in Paris and many foreigners visited the Exhibition, and made purchases sufficient to afford some temporary relief to the necessities of the workmen. On the morning of the day fixed for the opening, however, the walls of the city were placarded with the decree of the Directory for the expulsion of the nobility; the chateau of St. Cloud was given into the custody of a company of dragoons, the Marquis d'Avéze was in the proscribed list, and thus ended the scheme which had begun with so much promise. Early in the following year, however, on his return from proscription to Paris, the marquis resumed his labours. The place selected for the Exposition was the Maison d'Orsay, Rue de Varennes, No. 667; and it proved so attractive and successful that the Government determined to adopt the idea and to carry it out on a grand scale. An admirable opportunity was afforded on the return of Napoleon from the successful termination of the Italian wars; and on the same spot in the Champ de Mars on which the army had celebrated the inauguration of Italian spoils, and only six weeks after that fête, the nation erected the "Temple of Industry," around which were arranged sixty porticoes filled with objects of use or beauty. The Exhibition remained open only during the last three complementary days of the sixth year of the Republic: but it excited the greatest enthusiasm throughout the country. The merits of the several Exhibitors, who numbered 110 in all, were entrusted to the decision of a jury composed of nine men, distinguished in science and in art; and this plan was found to work so well that it was continued in subsequent Expositions, the only change being an increase in the number of the jurors.

The success of this Exposition was so complete that the Executive determined in future to have an Exposition every year, which should include also the provinces. Accordingly they addressed letters to the préfets of departments, requesting them to form committees whose office it should be to determine what local products were worthy of being forwarded to Paris at the public expense, and of becoming eligible to compete for a prize either of 20 silver medals, offered by the Government, or of one gold medal to be awarded to anyone who should have opposed the most formidable rivalry to British manufacture.

Although it had been decided to have annual Expositions, there was nevertheless an interval of three years between the first and the second official Exposition, which latter took place in the quadrangle of the Louvre, in 1801, under elegant porticoes erected for the occasion. Two hundred and twenty nine Exhibitors were admitted to the competition. Seven who had already obtained gold medals were set aside, and the eight best manufacturers placed in the second order in 1798 were separated from the list, in order to reserve the silver medals for their equals in industry; and hence arose the custom of voting only confirmation of previous rewards in favour of those who honourably maintained their already acquired position. It was on this occasion that Jacquard obtained a bronze medal, and subsequently an annuity of 1,000 francs, which was ultimately increased to 6,000 francs.

The next Exposition was held on the same spot in the following year, and in it the number of Exhibitors had again doubled, amounting to 540. The Exposition had by this time lost its exclusive and aristocratic character: articles in common demand were largely exhibited, and among the striking features of the collection were the extended application of mechanical and chemical science to facilitate production, and consequently to reduce the price of articles in popular demand. Twenty-two gold medals were distributed for such inventions or improvements as the hydraulic-ram of Montgolfier, the stocking-frame of Aubert; the silk-spinning machine of Vaucanson, and the chemical products of Decroisilles of Rouen, and Amfry and Darcet of Paris. One of the immediate results of the extended popularity of these Expositions was the establishment of the 'Société d'Encouragement,' which afterwards greatly assisted in developing the inventive genius of France, and in the application of abstract science to the wants and requirements of manufactures. This was followed by the fourth Exposition, in 1806, in which appeared for the first time the printed cottons of Mulhausen and Logelbach. The manufacture of iron by the aid of coke instead of charcoal, and that of steel by an improved process, and the application of the power of transferring ornaments from copper-plates to the surface of porcelain, were amongst the improvements which there marked the progress of manufactures.

An interval of thirteen years took place between the fourth and the fifth Expositions. The leading feature in the fifth Exposition was the improvement in the art of metallurgy; the great iron-works of the Loire contributed excellent castings, whilst the forges of Grossouvre (department of Cher) sent specimens of rolled iron. Four years after this the sixth Exposition, held in 1823, marked the progress which had been made in the application of the improved manufacture of iron to machinery and construction, and the consequent development of Civil Engineering as a profession. A model of the first French Suspension Bridge, designed by Messrs. Séguin, intended to cross the Rhone between Tain and Tournon, was there exhibited. After another interval of four years, the seventh Exposition was opened on 1st August, 1827. The collection exhibited showed the influence which steam, as a motive power, was beginning to exert on manufactures, both by improving their quality, and cheapening the cost of their production.

The eighth Exposition was opened in the Place de la Concorde, on 1st May, 1834. Among the chief novelties exhibited there may be mentioned paper-hangings printed from cylinders, by Zuber, of Mulhausen; the revival of the arts of enamel and niello by Wagner; the formation of elastic tissues by means of india-rubber; the revival of the art of wood-engraving, and the attempt to rival the excellence of Boule and Riessner in marqueterie and inlaid work.

The ninth Exposition, held in 1839, illustrated the steady development of success in manufactures in the production of vast quantities of goods at the lowest prices, a practice which had not previously found much favour in France. Five years after this the tenth Exposition was opened on 1st May, 1844, and it is said to have been the most successful of the series, and to have illustrated in the most decided manner the influence of long-continued peace on the industry and productive powers of France. On that occasion the first specimens of Daguerreotype were exhibited. Altogether no fewer than 3,960 manufacturers exhibited, of whom 3,253 were more or less honourably recognized by the jury.

After an interval of five years came the eleventh Exposition, which was opened in the Champs Elysées on 4th June, 1849. Since the former Exposition the empire of Louis Philippe had been swept away, and a republic raised upon its ruins; arrangements were, however, made for giving it an air of greater magnificence than any which had preceded it. The area of the building (exclusive of an enormous agricultural shed) was equal to about 5 acres 2½ rods; the number of exhibitors amounted to 4,494, and that of the central jury to 64. In this Exposition live stock and agricultural produce were, for the first time, admitted to compete for prizes. It is worthy of remark that previous to this Exposition the idea was proposed, and rejected, to invite other nations to contribute, in order that the French might be made acquainted with the skill of those nations with which they so often come into competition in foreign markets. The building erected for the purposes of this

Exposition was placed on the Carré de Marigny, a large oblong piece of ground abutting on the main avenue of the Champs Elysées. The architect was M. Moreau. The whole plot covered a parallelogram of about 675 by 328 feet English, round the outline of which was a gallery about 90 feet wide, divided into two avenues by a double range of pilasters.

In England, the Society of Arts may claim the credit of having originated national exhibitions. In 1756, about the period when the Royal Academy first began its Fine Art Exhibitions, that Society offered prizes for improvements in the manufacture of tapestry, carpets, porcelain, and other things, and exhibited the articles which were offered for competition. It also offered prizes for improvements in agricultural and other machines, and, in 1761, a gentleman was paid to attend an exhibition of machinery in the Society's rooms, and to explain the models exhibited. The progress of national exhibitions in England was not by any means so marked and steady as in France. Such industrial displays had to fight their way against a vast amount of apathy and prejudice. The first project set on foot for commencing an annual public exhibition of this kind was coldly received, and even denounced by the mouthpieces of public opinion. This Exhibition, however, was formed in 1828, under the patronage of King George IV., on the plan which had been found successful in France, the Netherlands, and the United States; and the King's Mews at Charing Cross, which stood on the site of Trafalgar Square and was pulled down in 1833, was fitted up to receive the few productions sent in for exhibition. The Exhibition was opened on Monday, June 23rd, 1828, and was described by the following title:—"The National Repository for the Exhibition of Specimens of New and Improved Productions of the Artizans and Manufacturers of the United Kingdom, Royal Mews, Charing Cross." This National Repository met with a most decided opposition from the public, but it succeeded in struggling through some four Exhibitions of decreasing merit; and when it left the King's Mews, in 1833, it still carried on a languishing business for a short time at a room in Leicester Square.

During this time the Society of Arts had continued to give their attention to the subject. In 1829 the Secretary of the Society read papers on several of the leading industries of the country, and from that date specimens of raw materials, manufactures, and new inventions were frequently collected in the old rooms in the Adelphi. Then followed local Trade Exhibitions, held at Manchester, Birmingham, Leeds, Dublin, and other places; and the Exhibition of Manufactures at the Free Trade Bazaar, held in Covent Garden Theatre in 1845. In that year the Society of Arts tried to revive the idea of forming periodical Exhibitions of Industrial products in England on the plan of the French Expositions.

A committee was appointed for the purpose, and a fund subscribed to meet the preliminary expenses; but owing to the want of sympathy on the part of the manufacturers the project was not then proceeded with. On the late Prince Consort becoming President of the Society, he advised the encouragement of the application of the Fine Arts to our manufactures. A special prize fund was accordingly established, and premiums and medals were offered for the production of manufactured articles of simple form. The first competitive designs were to be sent in to the Society on or before the 15th May, 1846, and the articles rewarded with prizes in that year, together with those sent in for competition in 1847, formed the basis of the first Exhibition of "Select Specimens of British Manufacture and Decorative Art," which was opened at the house of the Society of Arts in March, 1847. Very few competitors came forward in 1846, and the Exhibition of 1847 would have been a total failure but for two individuals, who made it a point of personal favour with a few great manufacturers to be permitted to select from their stores a sufficient number of articles to make a show. The result was highly satisfactory. Twenty thousand people visited the Exhibition, and the Council arranged a third display, which was opened in March, 1848. This time the contributions from manufacturers were sent in unsolicited, and even forced upon the Society, and upwards of seventy thousand persons visited the Society's rooms. The Society's Exhibition of manufactures in 1848 was followed by an Exhibition of pure art, known as the "Mulready Exhibition." In June of the same year, and at the opening of the Society's session in November, 1848, its first exhibition of models of machinery was announced to take place in January, 1849. In the spring of 1848 the third general "Exhibition of Recent Specimens of British Manufactures and Decorative Art" was held at the old house in the Adelphi, and this Exhibition was closely followed by a second art display, known as the "Etty Exhibition," which took place in the same rooms in June, 1849.

In the year 1849 an Exhibition of Manufactures and Art, in connection with the meeting of the British Association for the Advancement of Science, was held at Birmingham with very encouraging results; and the success of the French Exposition, held during the same year, coming as it did just as the country had embarked on its career of partial free-trade, gave a fresh impulse to the idea of holding a great National Exhibition of British Industry. The promoters of the scheme at that time contemplated only a national exhibition, and they asked for pecuniary aid from Government to enable them to carry it out.

Many have advanced claims, since 1851, to be considered the originators of the proposition for holding universal or international Exhibitions. M. Boucher de Perthes, President of the 'Société

Royale d'Emulation of Abbeville,' boldly recommended the holding of an 'Exposition Universelle' in the year 1834, in an address which he then delivered to the Society. The Prince Consort was the first to take the Society of Arts' plan for an enlarged national display in hand, and to mould it into an universal exhibition; and, at a meeting held at Buckingham Palace, on the 29th June, 1849, he suggested the four great divisions of Raw Material—Machinery and Mechanical Inventions — Manufactures — and Sculpture and Plastic Art, of which he proposed the Great Exhibition should consist. In July of the same year a general outline of a plan of operations was drawn up, and after they had become more matured, meetings were held in fifty towns; and by January, 1850, the names of sixty thousand influential persons had been obtained as supporters of the great plan. At a banquet at the Mansion House, in May, 1850, the Prince Consort stated that the proposed collection and exhibition in one building of the works of industry of all nations was "to give a true test and a living picture of the point of development at which the whole of mankind had arrived in this great task, and a new starting point from which all nations will be able to direct their further exertions."

Upon the presentation of reports prepared under the direction of the Society of Arts, a Royal Commission was issued, in January, 1850, in order to carry out all the necessary details of arrangement for accomplishing the great object in view. The ultimate result was the establishment of the Exhibition in Hyde Park, in the year 1851. The design for the building—which still exists in the Crystal Palace at Sydenham—was made by the late Sir Joseph Paxton, and its erection was entrusted, under contract, to Messrs. Fox and Henderson. The Exhibition was opened on 1st May and closed on 15th October 1851. After settling all claims, the Commissioners found themselves in possession of surplus funds amounting to 213,305*l.* 15*s.* 8*d.*, which was subsequently invested in the "Gore House Estate," and other property at South Kensington.

The great financial and general success of the Exhibition of 1851 naturally encouraged the repetition of such displays all over the world. There was the Cork Exhibition in 1852; two were started simultaneously in 1853, one in New York, and the other in Dublin, both of which were universal exhibitions. The Munich Exhibition came next, in 1854; this display was not international in the broadest sense, but the whole of Germany was allowed to take part in the competition. The twelfth Exhibition in Paris followed this in 1855, which was the first great French International Exhibition. It imitated very closely the plan of 1851. The exhibitors, although showing a decrease upon those of 1851 in London, showed a marked increase upon those of the eleventh French Exposition in 1849; and the building in which it was held still exists in the Champs Elysées, and is known by the name of the Palais de l'Industrie. After this great international display came the Manchester Fine Art Exhibition in 1857; the Dublin Art Exhibition, the Edinburgh Art Treasures Exhibition, and the Italian National Exhibition at Florence, all in the year 1861; the second great London Exhibition in 1862; and the second International Exhibition in Dublin in 1865. Since the last London Exhibition of 1862 there have also been International Agricultural Exhibitions held at Aarhaus in Denmark, and at Vienna; an International Cheese Exhibition near Paris; Fishery Exhibitions at Christiania, Archangel, and Boulogne, and the grand International Flower Show, which took place last year in the Horticultnral Gardens at South Kensington; and finally, the Paris Exhibition of the present year.

Nothing could well be imagined more unsightly, or devoid of architectural pretensions, than the building erected for the purpose of the present Paris Exhibition; the Emperor himself has compared it to a huge gasometer, and perhaps no better idea of its unsightliness could well have been suggested. All outward appearance has indeed been sacrificed for the purpose of obtaining convenience of classification, and, at first sight the plan adopted appears to possess some merits, but in practice it has been found that the classification is not only unscientific but unjust. The Duke of Marlborough, in a memorandum read to the British jurors on the 20th April last, called their attention to the difficulties arising out of the system adopted whereby, as he stated, "objects are locally placed in one class which possess elements for the consideration of several juries." The very use of juries in international exhibitions has indeed began to be seriously discussed; and, in the same memorandum to which we have just referred, it was suggested that "as furnishing materials for a future report it would be desirable, while the subject is fresh, to note down the opinions of the many eminent gentlemen employed as to the working of the international juries generally, the mode of procedure they have found it desirable to adopt in their several cases, the success that has attended it, and the opinion that the jurors have formed from the experience of this Exhibition of the utility of juries at all International Exhibitions."

In the plate which accompanies this article we have given a front elevation, drawn to scale, of the four great International Exhibitions of London and Paris. The buildings of the three earlier Exhibitions have already been repeatedly described, and we shall, therefore, not further allude to them in the present article, but pass on to give a hasty description of the Paris Exhibition of 1867.

This building, standing in the centre of the Champs de Mars, is in the form of two semicircles connected together by parallel sides, and the entire structure may be said to consist of a series of concentric rings arranged around a central garden. In the middle of this garden is a small circular domed building, containing a collection of all the standard weights and measures of different countries; and at the boundary of this garden, and inside the inner circle of the Exhibition building, is a covered piazza which formed a favourite lounge for visitors. Around the inner circle are arranged, concentrically, a series of galleries, or arcades, of varying dimensions, intersected radially by sixteen avenues leading from the outer to the inner circles, and a second covered piazza runs round the outside ring of the building. All the inner galleries are lighted from the roof, but the covering of the outside gallery, which rises to a height considerably above the rest of the building, is unpierced, light being furnished to it by a row of clerestory windows on either side surrounding the entire building at an elevation above the roofs of the adjoining galleries. The inner galleries which contain the Fine Arts court, and the History of Works Museum are built of solid masonry, with roofs of iron and glass of no great span. The intermediate galleries consist of light trussed wrought-iron roofs, supported on hollow cast-iron columns, and on the apex of each roof is a skylight, by which the gallery below is lighted. This portion of the building in no way enters into composition with the articles exhibited, and, with the exception of the roof, it may, for all practical purposes of effect, be said to have disappeared. The great exterior circle, or nave, is 110 feet wide and nearly 82 feet high in the centre; the pillars supporting it, of which there are 86 pairs, are each 83 feet 6 inches in height, and 62 feet 10 inches to the springing of the arched roof. In this gallery machinery was principally exhibited, and in its centre a raised platform, supported on cast-iron columns, extends right round the building in an unbroken line, excepting where it is intersected by the grand avenue, from either side of which it is approached by a flight of steps. The columns supporting this promenade served also to carry the shafting by means of which motion was communicated to the machinery.

This great zone has an outside diameter of about 1,550 feet lengthways, and 1,250 feet across, and contains an area of upwards of 11 acres, whilst the entire Exhibition building, with the central garden, occupies a space of about 35 acres. It would be impossible, however, to state the actual area of the space occupied for the purposes of exhibition, for all the surrounding park, having an area of about 70 acres, is studded all over with annexes and other buildings erected by the many exhibitors who could not obtain space within the main building. Besides the general annexes there have been erected in this park lighthouses, theatres, a club, churches, various manufactories for glass-blowing and cutting, baking, washing, &c. &c.,

model cottages, restaurants, besides houses for pumping and blowing engines, boilers, &c., connected with the ventilation, steam and water supplies to the Exhibition generally. In one corner of the park, which has been railed off, a *jardin réservé* was formed, in which exhibitions of fruits, flowers, and vegetables were periodically held; and one interesting part of this garden was the establishment of two huge aquariums, for salt and fresh water fish respectively.

It has already been stated that the building is arranged in a series of annular galleries, and each of these devoted to the exhibition of a certain class of objects; thus, the innermost circle contained a collection illustrative of the History of Labour from the earliest known period. Gallery No. I. contained Works of Art, including paintings, sculptures, &c.; No. II. Apparatus and application of the Liberal Arts; No. III. Furniture, and other articles for the use of dwellings; No. IV. Clothing, and other articles of wearing apparel; No. V. Raw and Manufactured Products; and No. VI. Machinery, including instruments and processes employed in the useful Arts. Outside of the machinery gallery a smaller court was devoted to the exhibition of Articles of Food in different degrees of preparation, where also were restaurants of all nations, in which trial might be made of all the Continental, English, American, and Oriental styles of preparing and serving up food.

In order the better to show such various agricultural operations as could not be carried on within the limits of the Champ de Mars, an Exhibition was organized on the Island of Billancourt, where competitions and trials of agricultural machines took place for the purpose of enabling the juries to make their awards. And an exhibition of live stock was likewise held fortnightly at the same place.

The total number of exhibitors was upwards of 42,000, showing a considerable increase on any previous Exhibition. Thus, in 1851 the number of exhibitors was under 14,000; in 1855 there were 24,000, and in 1862 the number did not quite come up to 29,000.

The Exhibition illustrative of the History of Art was certainly a novel feature, but it contained articles more stictly adapted for a museum than for an Industrial Exhibition. In this respect it was somewhat out of place, and, irrespective of the interesting nature of its contents, its introduction possessed no charm to recommend it beyond that of novelty.

The collection of pictures could not for one moment compare with that of 1862, since they were all to have been produced within the last 12 years, and consequently the works of ancient masters were necessarily excluded. England could make but little show, since the best examples of her paintings admissible under the rules are private property. The French collection was large rather than choice; and perhaps the best collection altogether was that from Belgium, the chief portion of which was contained in a separate building erected in the park. In statuary the French and Italians were almost without competition, scarcely anything of this class having been sent from England, and it will be sufficient here to state that the richest treasures from the museums of each of the former countries were to be found in the Exhibition.

Photography, hardly known in 1851, occupied no small space within the building. The positions obtained by salts of silver, or by the carbon process, have recently been much improved; and the productions of enamels, one of the most interesting applications of Photography, has made great progress; but one of the chief improvements is that of the heliographic process, by which Photography may be converted into processes of printing by means of ink, either on metal or on stone. Although a positive and satisfactory mode of fixing photographic pictures in their natural colours on paper has not yet been invented, coloured pictures have been obtained on paper, when, until last year, they could only be produced on metal.

A very general improvement was noticeable in furniture and decoration; but with the exception of one or two individual pieces of furniture, the merits of different countries have been more evenly balanced in this than in any other branch of labour. The principal improvements are due, to a great extent, to the employment by manufacturers of distinguished artists, whose co-operation has introduced art and good taste into the manufacture.

In porcelain the French and English are almost the only large manufacturers. And although the French claim the first place, they themselves admit to great improvements in the manufacture of Faiënce from the introduction of the methods employed in England. The substitution of coal for wood in the baking of porcelain in France has led to a reduction in its price, and great improvements have been introduced into the art of decoration through the cromolithographic process. The French, and indeed nearly all the continental porcelain, is of the *pâte dure* variety, whilst the English alone manufacture the famous *pâte tendre* sort. The colours also of some of the English porcelain may truly be said to have been unsurpassed in the Exhibition. In clear cut-glass the English remain unsurpassed, and in imitations of the Venetian and Bohemian, the products of England compare, not unfavourably, with specimens of manufacture from those countries.

In Telegraphy there has been a good deal of quiet progress going on since 1862. In Submarine Telegraphy more has been achieved since 1862 than in all the years that preceded it; and in consequence of the experience thus gained, engineers have, almost without exception, discarded cables completely iron-sheathed, and are adopting the last Atlantic model, consisting of a few iron or steel wires embedded in hemp.

In no former Exhibition has there been so good a collection of raw and manufactured produce; but the specimens were often so widely scattered that it became a task of no little difficulty to make fair comparisons. Great attention was given to mining and mining apparatus, especially by France, and her collection of Civil Engineering models was one of the most interesting parts of the whole Exhibition.

Since 1862 France and Belgium have wonderfully improved in the manufacture of iron and steel, so that this country is not now so far ahead in its iron manufacture as was formerly the case. Foreigners now, also, make more of their own tools and machinery than heretofore; and although their best specimens are generally copies from English models, they can now, for all practical purposes, turn out in many places as good machinery as could be obtained in this country; in excellency of design, however, and in finish, there is still no country that has come up to the standard of English manufactures. Alarmists have raised the cry that England is not keeping pace with the advancements of other countries, but we are disposed rather to believe the truth to be that whilst we steadily advance, other countries, which a few years since were much behind us, have made themselves acquainted with all that we possess, and thus are able to make more rapid strides, and to lessen the distance between us and themselves.

It has been, undoubtedly, principally through the instrumentality of International Exhibitions that other countries have made themselves acquainted with our arts, and we have learned theirs; and thus the diffusion of knowledge throughout the world has been hastened and extended. The rapid growth of these Institutions may at length be said to have reached a fair limit, and although the first International Exhibition resulted in a large pecuniary surplus, subsequent ones have not, in most cases, even succeeded in paying their expenses, and it stands to reason that the larger the Exhibition, the more expensive it must be, and consequently the less likely to prove remunerative. For the future, then, it may be anticipated that International Exhibitions will not be so general as heretofore, but will rather be confined to one class of objects, by which means it will be possible to hold them in some permanent building for which a rent only would be paid, and thus the chief expense which now attends their promotion will be obviated.

III. ON THE LUMINOSITY OF THE SEA.

By Cuthbert Collingwood, M.A., M.B., F.L.S.

During my recent expeditions as Naturalist on board H.M.S. 'Serpent,' one of the subjects to which I was anxious to pay especial attention was the luminosity exhibited by the sea, its appearance and various forms, the various conditions under which it became manifest, and, as far as possible, the causes which produced it. These points have already engaged the attention of observers, but much remains yet to be learned, nor shall I profess to add a great deal to what is already known, but shall simply relate the result of my observations carried on at every opportunity during a year and a half. Not a night passed while I was at sea without my looking out for luminous appearances—jotting down anything novel or unusual, and where practicable, making an examination for the detection of the cause of the luminous appearance;—and although the moonlight nights were very beautiful, I often bewailed the invisibility of the luminous animals whose light was extinguished by the effulgence of the moon's rays, and longed for a return of the dark nights when the brilliancy of the stars compensated for the absence of the moon, without putting a stop to my observations on the luminosity of the sea.

I would classify all the cases of luminosity which have come under my observation under the following five heads:—

1. Sparks or points of light.
2. A soft, liquid, phosphorescent effulgence.
3. Moon-shaped patches of steady light.
4. Instantaneous recurrent flashes.
5. Milky sea.

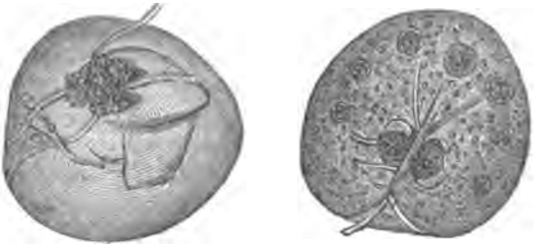
The first of these, or the appearance of points or sparks of light, is by far the most common, and in different degrees may be said to be all but universal. Whether the other forms of luminosity are exhibited or not, sparks of light in greater or less abundance are scarcely ever absent. The sea, more particularly when agitated, sparkles with brilliant points of light, varying in size from that of a pin's head to that of a pea—and of greater or lesser permanency—some being almost instantly extinguished, while others retain their light for an appreciable time. I do not think I ever looked at the sea on a dark night without seeing some few sparks, even though I might enter a remark that the sea was "*not* luminous to-night." But usually these sparks are abundant, and on occasions they present a wonderfully brilliant appearance. On one occasion, when this phenomenon was unusually striking, on the coast of China in lat. 26° N., on drawing up bottles full of water and pouring it out in the dark, the water sparkled brightly as luminous points ran over, but a close inspection revealed nothing in the water but a few minute entomostraca. On another occasion when some water which had been left in a basin exhibited luminosity at night, I got a very brilliant spark upon my finger, and taking it to the light, it proved to be a minute crustacean.

The second form of luminosity to be noticed occurs comparatively rarely. It consists of a soft, usually greenish light, which only makes its appearance when smooth water is disturbed, and is only seen in calm weather. This form appears identical with what we see nearer home, as on the shores of Ostend and in the estuary of the Mersey. This form of luminosity I have observed on only three occasions, and under similar circumstances, and I have reason to believe that the cause is the same on all occasions, whether in the Eastern seas or in the Mersey. On the 5th of July being on the coast of China, in lat. 27°, the weather in the afternoon became dead calm, and after sunset I remarked that the sea was beautifully luminous, but altogether without conspicuous sparks or points of light. Wherever the ripples caused by the advancing ship rolled away, they were crested with bright green light, and the ship's hull appeared to be enveloped in a luminous sheath. On this occasion the effect did not last long, and I did not examine the water microscopically.

The next time I noticed this form of luminosity was in Singapore harbour, on November 6th. The wind was east, thermometer 76°, weather fine. The water was like glass, smooth and beautiful, but exhibited no light except when disturbed; but every oar-stroke of the boat in which I rowed produced eddying circles of light, and a lovely soft green glow crowned every ripple from the bows. A splash in the water produced a shower of a myriad minute sparks, the aggregate of which made up this delicate luminosity, which I never saw so beautifully exhibited as upon this night. The following night the same effect was visible, but scarcely so intense as before (wind N.E., temp. 76°), and on the third night (the wind being E. and temp. 75°), I again observed it. After this I was absent from Singapore two nights, and on my return I no longer noticed the luminous effect.

On each of these three nights, I examined the water;—as I filled a bottle, bright sparks of light adhered to my hands, and on bringing it to the light I found that it contained a number of small globular greenish bodies, which floated upon the surface for the most part, but appeared to have the power of freely moving in the water. On closer examination these bodies proved to be *Noctilucæ;* and during the night I observed that the contents of the bottle frequently flashed with bright and rapid coruscations. I had no difficulty therefore in coming to the conclusion that the peculiar luminosity in the harbour was due to the presence of innumerable *Noctilucæ.*

On the 24th of May, lying in Simon's Bay, Cape of Good Hope, the water was similarly luminous. The weather was fine, wind W.N.W. light, bar. 30·04, thermom. 60°. On examining the water closely I found that, as before, the luminous effect, though soft, subdued, and apparently uniform, was really due to innumerable small sparks, and on bringing the water to the light, I found numerous Noctilucæ in it, precisely similar to those observed at Singapore. They were not, however, in sufficient numbers to have produced all the light, for in a wine-glassful of water there were on an average not more than a dozen Noctilucæ. But besides these bodies, there were a great number of motes in the water, many of which on closer examination appeared, by their rapid jerking locomotion, to be minute Entomostracous Crustacea. They were so minute, that by the imperfect light on board ship I long tried, in vain, to secure one to place under the microscope. Besides these were some larger species of Entomostraca.



NOCTILUCÆ.

The Noctilucæ measured from $\frac{1}{55}$ to $\frac{1}{50}$ of an inch in diameter; they were of a pale greenish colour when seen with the naked eye, closely resembling Volvox in appearance, but with a much less active movement. They had, however, powers of locomotion, though the means were not apparent under the microscope. They had a dark nucleus, usually irregular, but in some cases spherical and well defined. Their circumferential outline was very faint, and their general aspect very variable. A kind of slit appeared to extend through two-thirds of the body, from which faint lines radiated, usually having a double outline, and not reaching the circumference of the sphere, but often terminating in large round granular bodies of various sizes. The whole body was studded with oil globules of various sizes, which strongly refracted the light; but slight movements, which appeared to be taking place in an almost imperceptible manner, soon changed the whole aspect of any individual Noctiluca while under observation, so that the description or drawing of one minute did not answer for the next. Each Noctiluca had a large curved cilium projecting beyond the body, and apparently taking its rise from the nucleus. This form of luminosity, although very striking, appears to be completely extinguished by moonlight, even when the moon is young. It appeared, only less marked, on the two following evenings, and on the third we left the bay. I am informed that Simon's Bay has been remarked as frequently exhibiting this phenomenon.

On the 7th of July, in lat. 28° N., on the coast of China, two days after the occurrence of this form of luminosity, as before noticed, a heavy swell coming in from the S.W. was met by a N.E. wind, and the ship rolled tremendously. The sea was beautifully luminous, every wave breaking into a pale light which was visible at a considerable distance, so that the whole sea was streaked with light, and again that peculiar phenomenon of the ship sailing in a luminous sheath was visible. The night was very dark, and it was lightning vividly and incessantly; the whole scene was eery and weird in the extreme. I mention this case because it was one of the most striking instances of general luminosity which has come under my notice; it appeared to be compounded of the two forms I have already described.

The third form of luminosity to be described consists of moon-shaped patches of steady white light, which I have found to be a very common phenomenon under certain circumstances. Next to the occurrence of sparks and always accompanied by them, this form of luminosity is most frequently seen, and does not appear to be confined to any particular locality. I first observed it in the Mediterranean, on the first night on which the absence of the moon allowed it to be visible, and I have since found it to be no less frequent in the Red Sea, the Indian Ocean, the China Sea, and the Atlantic, north and south of the equator. It is most commonly visible in the wake of the ship, and consists of numerous round patches of light, which might be mistaken for white-hot shot of various sizes beneath the water at different depths. Sometimes, when deep down, they were pale and of a whitish colour, with indistinct outline, and of large size, but when nearer the surface they were smaller and more distinct, and assumed a pale greenish tinge. They usually remained visible for 8 or 10 seconds, but sometimes less. As these appearances were just such as might be presented by the umbrellas of large Medusæ, were such present and luminous, I was strongly inclined at first to attribute them to this cause; and the fact that on one occasion (about a week after I left England) I saw these moonlight patches in the Red Sea on the evening of a day on which the ship had passed through a shoal of Aureliæ, led me to attribute them to this cause. I supposed that the Aureliæ, struck by the screw, gave out their light under the excitation of the blow, and floated away luminous and dying. But I was forced to abandon this theory afterwards, for I have since many times watched for floating Medusæ before the light failed, and not seen one for days and weeks together, and yet the moon-shaped patches have been as bright and as abundant as before; and again, when we have passed through a thick shoal of Medusæ towards evening, the luminous appearances have not been more marked than usual, but even less so. Moreover, having secured one of these Acalephs, it has not exhibited any luminosity during the night.

Although, however, I ceased to regard the Acalephæ as the source of the luminous appearances in question, there can be no doubt that the great numbers which are always visible immediately under the stern are due to the fact of the eddies of the ship exciting the emission of light in certain animals capable of exhibiting luminosity. Not however that similar appearances are never seen in other situations where they are unmolested, though I must say that in my experience this is rare. Thus in the Indian ocean, in lat. 12½° N. and long. 55° E. (bar. 30°, them. 82°), among other appearances I noticed now and then a large patch of light with a roundish irregular outline pass by, emitting a pale and steady light, although out of the path of the ship; and on August 17th, being in a small boat on the coast of Borneo in a strong breeze after dark, I observed deep beneath the surface and entirely apart from any influence of the oars, the appearance of large globes of white light, shining persistently and spontaneously.

Although I long and constantly watched for the bodies which produced this remarkable and frequent luminous effect, I did so for a long time in vain. In vain I attempted to penetrate below the surface in search of any animals which could possibly originate the light. Although I could distinctly see the bottom of the ship's rudder, 19 feet deep, I could never detect a trace of any living thing within that depth by day, but no sooner did darkness supervene than they were often in abundance. It was only by accident, on June the 2nd, in lat. 28½° S., and long. 9° E., that I was witness of a circumstance which seemed to elucidate the question. Looking as usual over the stern, there were plenty of moon-shaped patches, accompanied by sparks unusually large and bright. The patches were remarkably persistent, and could be traced for nearly half a minute after the ship had passed. They were evidently a considerable but varying distance below the surface of the water; when far down they appeared large and faint and ill defined, but when nearer the surface they were smaller, brighter, and better defined. As I watched, one of the bright bodies whirled about by the eddy of the rudder came absolutely to the surface and exhibited a nearly rectangular form of great brilliancy, of a pale green colour, and as far as I could judge about six inches long by two broad. It at once occurred to me that it was a Pyrosoma, and that this Ascidian was the usual cause of the phenomenon, the circular form of the patches being produced by the diffusion of the light through a depth of water. I continued watching for a long time in hopes of seeing another, but although so good an opportunity did not occur again, many seemed to come near the surface, diminishing in size, but increasing in brilliancy as they did so; one particularly low down, suddenly gave out a dazzling brilliancy, producing a momentary effulgence all around.

I may mention that on a moonlight night when the moon has been dimmed by fleecy clouds, I have been able to see the moonlight patches, but when the moon shone out clearly they were no longer visible.

I have now to describe the fourth form of luminosity exhibited by marine animals, *viz.* momentary recurrent flashes of light. This form is nearly as commonly seen as the moon-shaped patches already described, which it very frequently, although perhaps not always, accompanies. If, however, the latter are well marked, the flashes are almost sure to be visible. I first observed them in the Indian ocean, north of the line, and since then, in the China seas and Atlantic. This appearance is very striking, but can only be seen under favourable circumstances, *i. e.* when the night is dark and the sea smooth. An indistinct transitory patch of light appears in the water, as evanescent as a flash of lightning; so rapidly does it come and go that it is difficult to fix the exact spot where it occurred. The brightness of the flash varies probably according to the depth of the animal producing it below the surface; sometimes it is of considerable brilliancy, and sometimes so pale that it would not have been noticed but for its suddenness. The colour is always whitish, and the form of the flash round, brightest in the middle, and becoming indistinct at the circumference. I have on some occasions seen these flashes occur in such numbers and with such rapidity that it would be impossible to count them, though more commonly they are comparatively few and far between.

But the fact which interested me most in these flashes of light was that they always occurred at a distance from the path of the ship. Although I have seen them accompanying the moon-shaped patches of light in the ship's wake, the places from which I could best observe the flashes were the forecastle or the gangways, when they could be seen in the smooth water several yards distant from the ship's side, and entirely uninterfered with by the ship's motion. This fact proved to me that there were spontaneous emissions of light by some animals below the surface, which voluntarily and at intervals gave out a bright coruscation. Moreover, although rarely, on following with the eye the spot where the flash appeared, it could be seen to reappear further astern, as though the emission was recurrent at definite intervals, as is the case with the luminous beetles called fire-flies at Singapore. I have also noticed on more than one occasion that the flash, instead of instantly disappearing, was followed by a faint glow which vanished gradually, but whether this was an optical illusion of the retina or not, I cannot be sure.

Whatever may be the animals which produce these luminous appearances, they must habitually swim at a considerable depth. I never was able to make out any definite outline of the light, which always appeared more or less spherical with faint edges, and sometimes the size and faintness of the flashes seemed to prove that the light must have been diffused by its passage through a great depth of water, which would also account for the whitish appearance of what is probably really greenish light. But I am strongly disposed to believe that the sources of the flashes and of the moon-shaped patches are identical; in the one case emitting their light spontaneously, and in the other, under the excitation of the eddies produced by the ship, and especially by the screw-propeller when at work.

Before quitting the subject of these flashes, I must not omit to mention that while at Singapore, having taken some small Medusæ in a towing-net in the Straits, I placed them in a glass which stood by my bedside. In the night I observed them flashing brightly with instantaneous flashes, of the same character as those above referred to, although not the slightest shaking was applied to the bottle, or irritation to the animals. So also the Noctilucæ of Singapore harbour, which I kept similarly in a bottle, flashed frequently with rapid and bright coruscations; and I am strongly disposed to believe that luminous marine animals in health, and acting spontaneously, without external irritation, always exhibit their luminosity in this manner, and that it is only when strong excitation is applied that they give out a steady but temporary glow.

There remains but one form of luminosity to be noticed, which although I have never been so fortunate as to witness it myself, has been observed by others, who have been longer at sea than I. This is what has been called *milky sea*, an extraordinary phenomenon of rare occurrence. It has been described to me as a general luminous glow, not confined to the crests of ripples or to disturbed water, but occurring in perfectly calm weather, and looking as though the whole sea was composed of a whitish fluid like milk, with no bright spots or sparks. Such an appearance reflecting a faint light upwards illuminates the ship, rendering every part of the rigging plainly visible, and inasmuch as it can only be seen in the absence of the moon, the contrast of the white glowing sea with the black sky produces an effect calculated to strike the observer with a kind of awe. Although I have met with persons who tell me they have not unfrequently seen this phenomenon, I am disposed to believe that it is extremely rare. One who has not really seen it at all might erroneously suppose, that such an appearance as I have already alluded to as having twice occurred to me on the coast of China (when the ship seemed to be sailing in a luminous sheath) corresponded to the description of a milky sea, and in a small way it did so, and I considered it, at the time, as the nearest approach to it I had ever observed. But the milky sea must be something *sui generis*, and I imagine it to be owing rather to a condition of the water under certain peculiar atmospheric or climatic influences than to any extraordinary number of luminous animals in the water. A circumstance which occurred to me seemed to throw some light upon the subject and confirmed me in this opinion. Having put down the towing-net in the Formosa Channel it collected a number of small entomostraca, megalopas, minute medusæ, small porpitæ, pteropods, annelids, globigerinæ, &c., which I placed in a basin of sea water, and not having finished my examination of them they remained upon the table during the night. On stirring the water in the dark the whole became faintly luminous, giving out a general glow as if every particle were phosphorescent, the minute crustacea, &c., appearing as bright spots in the luminous fluid. If the slimy substance, in which in some marine animals at least the luminous property appears to reside, become diffused through the water, as it is probable it may be under certain combinations of conditions and circumstances, a general luminosity of the water may result, similar to that observed in milky sea, while its small sparks, doubtless in great abundance, would remain unnoticed in the universal glow, but would at the same time greatly enhance the general luminous effect.

There is a common idea that a southerly wind is peculiarly productive of luminosity in the sea, but according to my observations this is an error. The winds most prevalent when luminosity has been well marked have been westerly, north-westerly, or even easterly, south being perhaps the least frequent; but probably the direction of the wind has no special influence in the matter. What the favourable conditions really are it is as difficult to say as it is in the case of floating animals generally. I have seen remarkable exhibitions on one night followed by nearly absolute darkness on the next, the conditions of wind, weather, barometer and thermometer, being inappreciably altered. Probably temperature is as important as any influence; the luminosity in the Mersey only occurs in summer, and in rounding the Cape of Good Hope during the winter season, scarcely any luminosity was exhibited during the month tnat we were passing through the higher degrees of S. latitute.

The animals which I have observed to possess luminous properties are not numerous. Many of the more minute animals taken in the towing-net appear to exhibit them, more particularly the small Crustacea (Entomostraca) and small Medusæ (Medusidæ).

I have no reason to believe that the large Medusæ (Lucernaridæ) as Aurelia, Pelagia, Rhizostoma, &c., exhibit any luminous powers, having kept specimens which have invariably failed to do so. Nor do I believe that the Physophoridæ are luminous. I have never seen a luminous Porpita or Velella; and although on one occasion, when magnificent specimens of Portuguese men-of-war had been floating by all day, my attention was directed to shining spots at night, under the supposition that they were luminous Physaliæ, I merely replied by pointing to a bucket containing one of these animals, but which was perfectly dark. I have seen a large prawn give out light after death, and a fresh squid was illuminated at night with an irregular glow of whitish light, which remained unaltered as I passed my finger over the surface. Nor do I believe the stories of luminous fish, inasmuch as fish rapidly swimming in a fluid abounding in minute luminous points, as the sea sometimes does, would present an effect which an uninformed or inaccurate observer would readily mistake as proceeding from the fish itself, instead of from luminous points which it disturbed in its passage.

IV. OUR FIELD CLUBS: THEIR AIMS, OBJECTS, AND WORK.

1. *Transactions of the Woolhope Naturalists' Field Club (established* 1851), *including the first part of the Flora of Herefordshire.* By the Rev. W. H. Purchas, L.Th., 1866.
2. *The President's Address and Reports for* 1866, *together with the Rules, List of Members, and Catalogue of Books of the West Kent Natural History, Microscopical, and Photographic Society.*
3. *The Proceedings of the Cotteswold Naturalists' Field Club for* 1865.
4. *Proceedings of the Bath Natural History and Antiquarian Club.*
5. *Report of the Liverpool Naturalists' Field Club for the year* 1866.
6. *Proceedings of the Bristol Naturalists' Society.* Edited by Wm. Lant Carpenter, B.A., B.Sc.

Naturalists' Field Clubs, compared with other societies devoted to scientific pursuits, are institutions belonging to a very recent period: the oldest of them, in this country, has not yet celebrated its jubilee, and few have existed so long as ten years; yet now no season passes without adding to the already numerous list.

The inquiry, "What are the objects of Naturalists' Field Clubs," may best be answered in the words of some of their most zealous promoters.

Sir Wm. Jardine, Bart., President of the Dumfriesshire and Galloway Natural History and Antiquarian Society, thus states the object of the Society:—"To secure a more frequent interchange of thought and opinion among those who cultivate Natural. History and Antiquities; to elicit and diffuse a taste for such studies where it is yet unformed; and to afford means and opportunities for promoting it."

G. S. Brady, Esq., Secretary of the Tyneside Club, says:—"The objects of Naturalists' Field Clubs may be said to be twofold. First, the study of nature out of doors, and (as being inseparably connected with this) the collection of specimens for more minute examination at home. Secondly, the preservation of natural objects from wanton useless destruction."

The Rev. Leonard Jenyns, President of the Bath Natural History and Antiquarian Field Club, says:—"There are two especial objects which a Club such as ours has, or ought to have, in view. One is the thorough investigation of the neighbourhood in which it carries on its researches as regards its Natural History and Antiquities; the other, the bringing together men of the same pursuits, with the addition of those who, without following up any particular branch of science themselves, may yet enjoy the society of those who do, or who may like to join the Club for the sake of its excursions, the health and exercise they afford, and the pleasure of rambling over new ground."

Leo. Grindon, Esq., Secretary of the Manchester Field Naturalists' Society, says:—"The great aim of the Society is to call forth and encourage latent taste for Natural History."

We are inclined to agree with the most liberal of these opinions, and to think that too much solicitude is sometimes shown by the managers of Field Clubs, to secure that no meeting should be without a prominent share of speech making or paper reading. No doubt the members of any voluntary association have a right to make their own arrangements, but if the Field Club be the agency to which we must look for the wide diffusion of a taste for Natural History, the excursion programme should in every case be drawn up with due consideration for the predilections of incipient naturalists.

We remember attending Professor Sedgwick's lectures at Cambridge, over thirty years ago: the class-room was not always crowded, but on the occasions when the accomplished Professor took the field, mounted on his well-known black steed, there was ever a goodly attendance of equestrian pupils at the meet; and if at the close of his ride, taken at a dashing pace right across the country, there were fewer students present at the concluding lecture, the falling off of his audience certainly did not arise from any mere geological deficiencies. It is said that some who joined the Professor's class, chiefly for the fun of the mounted excursion, afterwards became eminent as geologists.

It is, however, manifest that the successful working of a Field Club must depend on the suitability of its plans to the circumstances of its position. Field Clubs commonly belong to one or the other of two distinct classes. 1st. Such as occupy a wide field extending over a large portion of a county, and include amongst their members chiefly professional men, and men of independent position. 2ndly. Such as are established in populous towns.

To the former of these divisions belongs the Cotteswold Naturalists' Field Club, of which we need only say that the intellectual and genial character of its gatherings is such as to induce men of eminence in science, even when residing in London, frequently to attend its meetings. Its publications have not been issued regularly, but are of the highest scientific value.

The Woolhope Naturalists' Field Club has this year issued a volume of transactions, which plainly indicates the Club to be in a thriving and vigorous condition. The speciality of the work, however, mainly consists in that portion of it which contains the Flora of Herefordshire, edited by the Rev. W. H. Purchas. The Flora is accompanied by a map of the county divided into fourteen botanical districts: a schedule follows, pointing out the plants found in each district. The editor modestly disclaims originality in adopting this plan; but we do not know that it has been carried out with the same degree of completeness in any other county. The difficulty of obtaining satisfactory reports from so many districts must have been very great.

We quote from the advertisement:—"It has of late years been felt that a very imperfect view of the botany of any county was given by the plan on which the older Floras were drawn up; that plan being to mention stations for the rarer plants, or those supposed to be such, whilst it was left to be inferred that the remainder were equally common throughout the whole area to which the Flora related. The real truth being that species which, from their frequency in one part of a county, might be expected to prevail equally throughout its whole extent, are found, when specially sought after, to be comparatively local."

Whilst Field Clubs very rightly devote a good deal of attention to the geographical distribution of plants, it may be remarked that the geographical distribution of the Field Clubs themselves is a subject worthy of notice. A map of England marked with the stations of these Clubs would show them to be very unequally distributed. A belt extending from Lancashire along the western side of England to the south coast would include amongst others the following: Bath, Bristol, The Caradoc, The Cotteswold, Cheltenham, Dudley, Exeter, Liverpool, Malvern, Manchester, Oswestry, Preston (1867), Severn Valley, Somersetshire, The Teign, Worcestershire, and The Woolhope. In the rest of England the stations marked would be comparatively few and far between. Are we to apply to the geologists or the ethnologists for an explanation of this?

The list of Herefordshire plants is a large one: some of the districts, particularly that of Ross, have been fortunate in possessing a representative not afraid to attack such formidable botanical problems as the Willows and the Brambles. A list of plants, however, even if it were perfect, would convey but little instruction unless connected with information respecting the physical and geological features of the district to which it belonged. This want has been supplied by the Rev. W. S. Symonds, President of the Malvern Club, who has given an admirable account of the local and geological characters of each of the fourteen subdivisions of the county. It is announced that a future portion of the Flora will consist of a "more detailed mention of the different plants, and will give any further information that may seem needful."

The volume contains full reports of the excursions, referring to which Dr. Bull, the President, in his retiring address, remarks, "The published reports of our field days make people wish they had been with us." Not the least doubt of it! Who would not wish to share in such *dies ambrosianæ*, with salmon and the goodly haunch of venison on the board, and such men as Bentham (of the Handbook) and Brodie and Symonds as guests, besides the members of the Club, around it?

Before leaving the Woolhope proceedings we must refer to the series of photographs of remarkable trees in Herefordshire: these are not the only indications that this Club gives more than common attention to the subject of trees, too often almost neglected by botanists.

The Bristol Naturalists' Society differs from most others in having distinct sections for entomology, chemistry and photography, zoology, botany, and geology. A general meeting is held once in the month; the sections also have monthly meetings and excursions, and contribute funds to the library of the Society.

The Liverpool Naturalists' Field Club professedly aims at the extension of a taste for natural science, and seems to have ample scope for its efforts amongst its 720 members. Some peculiarities in its plan are thus noticed by the President:—"As the plan of giving prizes (books on natural history subjects) originated with our own Club, I may state that practically it has been found very successful. Many younger members of the Club, beginning with the prizes (at the excursions) most easily attainable, have been encouraged to proceed zealously with studies which otherwise would not have been entered upon; whilst some of the collections sent in for our annual prizes have far surpassed all our expectations." "Large numbers join our excursions who are not particularly interested in any branch of natural science, and this is just what the chief object of our Club renders a desirable circumstance. The busy appearance of our workers, who often come in when tea is half over, flushed with exercise and animated with success, is a suggestive lesson to others who may be found waiting at the door of our meeting room half-an-hour or even an hour before the appointed time; a lesson on the difference of the amount of pleasure afforded by a walk with a special object, and a walk without one." "Our numerical strength gives to our most valued members facilities for visiting localities at great distances, on terms which could not otherwise be obtained. We are able to engage a special train and make a journey of 160 miles in a day, at a cost, including a substantial dinner-tea, of about seven shillings each, allowing five hours for work at the locality visited."

Naturalists' Societies now in operation in Great Britain have upon their lists probably not fewer than 4,000 members: we may safely add an equal number to represent professors, students, collectors, and others not connected with any society, yet more or less actively engaged in the same pursuit, Such a company should be able to give a good account of the natural history of their own country, yet many interesting branches have been all but wholly neglected, and some are at present without even a moderately useful *Handbook*, *e. g.* The Fresh-water Algæ, the Annelids, and the Centipedes: but even in the pursuits which are most popular, much remains to be done. Members of Naturalists' Societies must be aware that a question is pending which in Zoology and Botany may open a field for investigation, comparatively, as vast as that annexed to astronomy by the invention of the telescope. Yet it is a marvel how few direct their efforts towards the acquisition of evidence for or against the hypothesis of the origin of species by natural selection. Facts well authenticated and chosen with discrimination on either side are equally and, at present, pre-eminently, the desiderata of natural science.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

The Cattle Plague has not yet entirely left us. During the past quarter several cases have occurred on farms lying eastward of London, to which the infection may have been brought by the imported stock which is landed at Thames Haven and taken into the Metropolitan Market by a railway passing through the district which has suffered. And thus it is, in all probability, that the disease has at length reached the farm and large herd of cows near Barking, belonging to the Metropolitan Sewage Company, to whose proceedings reference has more than once been made in this Chronicle. There were 238 cows on this farm early in August, feeding on the sewage-grown grass which is there cultivated. Of these 12 became diseased and were killed and buried, and 115 were condemned to be slaughtered as having been infected by contact with diseased animals. There then remained 111, in two sheds detached from the homestead, and these have remained healthy. They had been fed on the same food as the others, and being surrounded by the meadows irrigated by the sewage water, were not only thereby more easily and completely isolated from the other stock, but were at the same time more liable to any injurious influence which the sewage may be capable of exerting. It is satisfactory to learn from this experience, that neither on the food nor on the treatment of these cows can the losses by the Cattle Plague be charged, that sewage-grown grass is perfectly wholesome food, and that the Cattle Plague is, as it has always been supposed to be, simply the result of an imported poison, the special produce of the disease itself. Of the quantity as well as quality of the produce which sewage-water raises even on poor land, the experience of the Barking farm is satisfactorily conclusive. Flax, mangold-wurzel, potatoes, cabbages, and grass have been grown luxuriantly on it; and dressings of the young wheat-plant in spring and early summer have shown what immense bulk of straw can be thus ensured—from which, in suitable seasons, no doubt increased yield of grain must follow. Of the Italian ryegrass thus produced a record has been kept, and on many acres upwards of 50 tons per acre had been obtained from five cuttings by the middle of August. It seems certain that the produce of sewage applications, under all ordinary circumstances, must be sufficient to return a satisfactory profit after the deduction of expenses.

Professor Anderson has lately delivered at Glasgow an interesting lecture on recent laboratory results, in which he called attention to the state of the guano trade, the superphosphate manufacture, the quality of oil cakes, and of drinking water—all of them important agricultural subjects. He informs us that the guano on some of the Chincha islands is already exhausted, and that recent imports are of inferior quality—containing considerably more water and considerably less ammonia than the qualities which have hitherto been common—a difference capable of correction only by the artificial addition of at least 20 shillings-worth of sulphate of ammonia to the ton—"and to this extent the price of the guano is practically enhanced by this diminution of its quality." Of recently manufactured superphosphates Professor Anderson reports an improvement. They are indeed no longer manufactured from bones, but the process by which the mineral phosphates are converted is more completely carried out, and new supplies, of excellent quality, are from time to time discovered. Thus it has been lately met with in nests in a particular kind of dolomite in the valley of the Lahn, a tributary of the Rhine. The mines of Staffel yielded last year 2,500 tons of a quality containing 55 to 65 per cent. of phosphates. It is here in a new and unexpected geological formation, and there can be little doubt that by an extended search many similar deposits will be found.

During the past year Professor Anderson has found bran, grass seeds, carob beans, French nutcake, and other adulterations in oil-cakes of British manufacture. And we are informed of the offer in the market of inferior mixtures containing mustard and other small seed, with the avowed purpose of "reducing high quality linseed." A dealer in cakes, we are told, has sold at 11*l*. a ton an article, which he stated was of the highest quality, under the name of the "Simon Pure." It was found on analysis to contain bran, and since then he has supplied his customers with the *real* Simon Pure at 11*l*. 10*s*., "so that in commerce as well as in comedy there are a real and counterfeit Simon Pure."* Professor Anderson touched lastly on the character of the drinking water given to cattle. He has lately examined the water from wells on several farms, and has found them to contain nitrates obviously derived from the infiltration of animal matters. The presence of such matters is injurious to human beings, and is in all probability also mischievous to the live stock of the farm.

One of the more remarkable features of the annual show of the

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* For the guidance of analysts and of our agricultural readers, we may mention that the following substances are used for the adulteration of linseed cake: wheat-bran, ground rice-husks, inferior rape-cake, inferior groundnut-cake, Niger cake, damaged cotton cake, cake made from damaged linseed, Dodder cake, Sessame cake, Indian corn meal, locust beans, &c.; but the worst, and most valueless substance used is ground rice-husks, known as "shudes."

English Agricultural Society at Bury last July, was the illustration given of the economical application of steam-power to light-land cultivation. By means of two engines, one at either end of the cultivated field, two tools are worked at once; and when the widest tools were used—Fowler drags a 13-tine cultivator which takes a width of 4 yards at once—the cultivation was accomplished at the rate of 50 acres in a day. It seems plain that on light-land farms as well as clays, wherever the area has been properly laid out for steam cultivation there need in future be no more horse-power provided and kept throughout the year than will suffice for the harvesting and marketing of the crops; in fact, for all the work of carriage. With Fowler's or with Howard's double engines, each with double drum working two tools simultaneously, there is no reason why a square of 20 acres, or even more of land which had been ploughed by steam-power before winter, should not be grubbed or cultivated, and receive a thorough harrowing all at once in a single day in spring, or why a thorough fallowing after a winter's frost upon the autumn tillage of stiff clays should not be thus accomplished almost at a blow.

The hot and variable weather, accompanied by thunderstorms, of the current season has been greatly against the dead-meat trade; and some easy preservative of quality is under such circumstances greatly needed. Messrs. Medlock and Bailey have patented the use of their solution of bisulphite of lime for this purpose. Two quarts of this solution, one pint of common salt, and four gallons of water, constitute the wash, by which it is said that a joint of meat may be preserved fresh in the hottest weather. A dip night and morning into such a mixture will keep meat sweet for any length of time; and when afterwards dipped in cold water for a few minutes and then dried thoroughly with a cloth it is ready for cooking, unaltered in any detectable way from the day it was slaughtered. Such are the assertions of the patentees; and they are sufficiently striking to deserve examination.

The weather of the past spring and summer has proved on the whole better for succulent growth than for the formation and ripening of seed, and the reports of the grain harvest are not satisfactory. More than half the reports of the wheat crop supplied to the 'Agricultural Gazette' declare it to be under average, and that is a larger proportion than was similarly returned last year, when the crop was undoubtedly an inferior one. The crops of spring-sown oats and barley, and especially of beans, are believed, on the other hand, to be generally good.

2. ARCHÆOLOGY AND ETHNOLOGY.

YIELDING to the desire of the Belgian Minister of the Interior, M. Dupont has collected into a small octavo volume the first series of his papers on the Belgian caverns, under the title of "Notices préliminaires sur les fouilles exécutées sous les auspices du gouvernement Belge dans les cavernes de la Belgique." It contains notices of the caverns on the banks of the Lesse explored up to the month of April, 1866; of the caverns on the banks of the Meuse explored up to October, 1865; and of the author's researches into the Quaternary deposits of the valleys of both those rivers. These memoirs having been originally published in the Bulletin of the Academy of Sciences of Brussels are now tolerably well known, and require no further notice at our hands; but their publication in a compact form will be welcome news to the many English ethnologists and geologists who are interested in the progress of M. Dupont's researches.

Mr. J. S. Moore has recorded, in the Journal of the Royal Geological Society of Ireland, the finding of a stone hatchet, under interesting circumstances, at Kilbride, County of Wicklow. It was found imbedded in hard clay, and carefully covered by a large stone, fourteen inches broad, eighteen inches deep, and two feet long, perfectly flat on the under side, and weighing about 3 cwt. This stone was firmly imbedded, and wedged in by five other large stones, varying in weight from one to three hundredweight. About two loads of smaller stones were firmly and closely packed upon these. Stiff hard clay rose around the base of the large stones to the height of six inches, and from that up to the surface of the ground lay about 18 inches of bog. The author speculates on the means—natural and artificial,—whereby the hatchet may have been placed in the position in which it was found, and the most probable of his suggestions seems to be that it was hidden there by a native previous to the growth of the bog, and the accumulation of the clay around the base of the large stones.

A controversy on the subject of certain submarine forests on the shores of Liverpool Bay and the River Mersey has been carried on for some time past between the Rev. Dr. A. Hume and Mr. Joseph Boult. The latter gentleman in several papers, and especially in one recently published in the 'Transactions of the Historic Society of Lancashire and Cheshire,'* upholds the idea that the peat of this district has been derived from other localities where peat pre-existed, *e. g.* Chat Moss, and that the remains (Roman) found in it "are appurtenant to the original localities from which the peat is derived, and may furnish a clue to identify those localites wherever they may be." Dr. Hume in the same publication (p. 1) advocates the belief that the forests and peat are the result of growth *in situ*, and that in some cases there are successive beds of forest-remains separated by strata deposited by water. The Roman remains found near Great Meols he considers the proof of a Roman settlement; and the evidences of encroachments of the sea show that the land has been submerged since the growth of the forest. Mr. Boult's opinions being diametrically opposed to these, the two authors have brought together all the evidence they could obtain, and have thus produced two papers of considerable interest to local archæologists and historians.

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* New series, vol. vi., p. 89.

In the 'Comptes Rendus,' * M. Guérin has recorded the finding of a core and some flakes of *obsidian* in the neighbourhood of Lunéville, the material being the curious element in the discovery. For some time this remained an isolated fact, but the perseverance of M. Guérin has since been rewarded by his detecting near Aingeray—a small commune in the Department of the Meurthe,—some fragments of a vase remarkable for its shape and material; and very near it a chipped flake consisting of a vitreous substance. On putting together the fragments of the vase, M. Guérin recognized the shape to be the same as that of some found in accumulations of the Bronze-age in Alsace.

Sign. Gualterio has recorded† the discovery of a fossil human cranium in the Quaternary travertin of Viterbo, associated with bones of Ox, Goat, and a species of *Emys*. No opinion as to its more precise age is hazarded by Sign. Gualterio, but the probability is that it belongs to a very recent period, possibly within historic times.

The Archæological Institute, the British Archæological Association, and the Cambrian Archæological Association have held their annual meetings during the past quarter at Hull, Ludlow, and Hereford, respectively. Several churches, castles, and other buildings were visited; but little was done in reference to the Prehistoric period. We must mention, however, that a large tumulus, supposed to belong to the Roman period, was opened at Thruxton, near Hereford, during the meeting of the Cambrian Association.

In our last Chronicle we described some of the ancient inscriptions (Oghamic, Runic, &c.) of Ireland and Scandinavia, and we have now to record the publication of Mr. John Stuart's work, entitled 'The Sculptured Stones of Scotland,' in two volumes, illustrated by more than 200 plates. Our space will not allow us to describe the contents of this work; but we may mention that the sculptures include representations of men and animals, symbolical figures, and Pictish, Runic, and other inscriptions.

Two numbers of the 'Anthropological Review' (Nos. 18 and 19, for July and October), have been published during the past quarter. Their contents are for the most part remarkably speculative and general, rather than descriptive, which latter, in the youth of a science, we venture to think they ought to be. We shall therefore select only a few papers more especially worthy of notice.

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* Vol. lxv., No. 3 (July 15, 1867), p. 116.

† Atti della Società Italiana di Scienze Naturali, vol. viii., fasc. 4, p. 285

Mr. Carter Blake's paper "On the Human Jaw from the Belgian Bone-caves," is here published in full; but as we discussed the abstract of it in our last, we need do no more here than record the fact.

Mr. E. B. Tylor has a paper "On the Phenomena of the Higher Civilization traceable to a rudimental Origin in Savage Tribes," in which he attempts to show that certain customs still practised in civilized communities are traceable to a barbarous origin. For instance, "The astrology of Zadkiel's Almanac does not appear to me to differ from the old rules; the ordeal of the key and Bible is very old and widely spread; country people still make a heart and run pins into it to hurt the heart of some person with whom they choose to associate it, as any savage might do." All that Mr. Tylor writes is worth reading, and this paper is not an exception, for in many instances he shows how curious customs still extant amongst the superstitious crowd of a country fair have got their origin. But we take the liberty of asking, Can these exhibitions of superstition be dignified with the title of "the phenomena of the *Higher* Civilization?" Ought the author not to have said, rather, the Lower Civilization? It seems, however, that the term "savage" is sufficiently distinctive from "civilization" to render the use of any comparative adjective unnecessary. But Mr. Tylor may possibly regard the savage condition as a rudimentary stage of civilization, and has some name more glittering than civilization for the habits, customs, and modes of thought of the educated people of the present generation.

Dr. J. Thurnam has a paper in support of his theory that long skulls are found in long barrows, and short skulls in short barrows; but he qualifies it by admitting that while he considers the first part of his proposition to be strictly true, the second he concedes is subject to exceptions, and that the round skull is simply the *prevailing* type found in the round barrow. We cannot enter into the details of measurements, &c., by which the theory is supported, but for them must refer our readers to the paper, which is entitled "Further Researches and Observations on the two principal Forms of Ancient British Skulls." We may also mention that Mr. C. Carter Blake, in the next paper, "On certain Skulls from Round Barrows in Dorsetshire," endeavours to show that no such distinctions exist; but we have seen that Dr. Thurnam himself states that the "round barrows, round skulls" is not an absolutely rigid proposition.

Dr. Thurnam also endeavours to draw a distinction as to the relative ages of the two forms of barrows, and states that no well authenticated instance of the finding of metal, or of the finer decorated pottery, with the primary interments in long barrows was known to him; but only objects of stone, bone, or horn, and a peculiar coarse kind of pottery. In the round barrows, on the contrary, "objects of bronze (very rarely of iron) and richly decorated pottery are often found, with or without objects of stone." The author therefore referred the long barrows to the Stone-age and the round ones to the Bronze-age, and the period of transition from that to the Iron-age.

In a paper "On the Natives of Madagascar," Mr. Thomas Wilkinson shows the existence in that island of two distinct races of men—one inhabiting the sea-coast and the other the interior of the island. "The former have woolly hair, brown or black skins, strong white teeth, and in fact all the characteristics of a superior order of Negroes. Within the last few years this race has been conquered by the people inhabiting the interior of the island, who are called *Hovas*, and are generally slender, often small, with, in many cases, long, straggling, unsound, and ugly teeth, straight coarse hair, and light-brown skins, with faces resembling those of the Chinese or of other Mongolian races."

In a paper entitled "On Physio-Anthropology, its Aim and Method," Dr. Hunt endeavours to divide his science into two portions, namely "Physio-Anthropology," or the doctrine of the functions of mankind, and "Physical Anthropology," or the doctrine of the forms of mankind; just as in Zoology and Botany we have the divisions of Morphology and Physiology. Still, from the tenour of the paper, this comparison, which is instituted by Dr. Hunt himself, does not seem to be quite parallel, otherwise Physio-Anthropology is simply Human Physiology. What then is this new department of the science of man? Dr. Hunt says, "By physio-anthropology I mean, not the philosophy of the human mind, but the science of the functions of mankind;" and he further illustrates his meaning and rescues it from obscurity by remarking, "I have quoted from Mr. Spencer chiefly to show that the term I have employed, . . . differs in no essential respect from what that writer understands by human psychology generally." Apart from this subject, Dr. Hunt's paper is a resumé of opinions on the subject of Psychology, such as the question whether the size of the brain has any direct relation to intellectual power and capacity; the doctrines of phrenology; and many other kindred subjects of considerable interest, which are, we presume, the chief portions of Physio-Anthropology. It should be mentioned that Dr. Hunt partially justifies his classification and division of Anthropology by the action of the British Association last year. It is therefore unfortunate for his argument, that they have this year returned to their original classification of the sciences.

3. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

The question whether any change has really taken place in the lunar crater Linné still divides astronomers. Many distinguished observers have expressed the opinion that Linné continues unaltered. Mr. De la Rue considers that photographs of the moon taken before and since the period of Schmidt's supposed discovery, exhibit no such difference as to support the theory of change. The astronomers of Harvard College, Cambridge (U.S.), can discover no evidence of change with the magnificent refractor of their observatory. They are not, however, it would seem, opposed to the theory that changes may possibly take place upon the moon's surface, since they announce the occurrence of phenomena in Aristarchus, apparently due to the down-flow of lava-streams. Mr. Huggins also has given a view of Linné and a paper on the subject of Schmidt's discovery, in which he appears to oppose Schmidt's views. He states that Respighi considers the present appearance of the crater to be identical with that which it has always exhibited; but he adds that Lohrmann's description in 1823, and Mädler's in 1831, do not appear to be in accordance with either Schröter's observations or with the present condition of the object.

It is noteworthy that nearly every observer who has made the moon a subject of special study is convinced that a change has taken place. And not only so, but many distinguished lunarians are of opinion that the appearance of the spot is still changing. The black spot first seen on Linné by Mr. Buckingham on Dec. 14 under morning illumination, next by Herr Schmidt on December 26 under evening illumination, and resolved into a crater by Secchi on February 11, has now become so distinctly visible as to leave little doubt that the orifice in Linné has become enlarged in the interval.

The question has now arrived at a very interesting stage, and we trust that observation will be diligently pursued.

In connection with this subject we may note that Mr. Birt has just issued two lunar maps, in red outline, so that observers who find any traces of change may mark in the alterations in black ink. These maps are on the scale of 200 inches to the moon's diameter, and comprise the space included between 0° and 6° West longitude, and 0° and 10° South latitude.

Astronomers are of opinion that we may look this year for a recurrence of the November shooting-star shower. Assuming the position of the meteor-stream to have remained unchanged, the maximum display should take place at about seven o'clock on the morning of November 14. But if we assume the shifting of the node (investigated by Adams) to take place uniformly, the epoch of maximum intensity must be placed at about twenty minutes past seven or five minutes after sunrise. This determination, however, does not take into account temporary disturbances in the figure of the ring. The progression of the nodes is not uniform, but subject to variation; neither is the ring always in one plane; and occasionally one of the nodes may regrede for a time. From the position of Jupiter it would appear that the node we traverse in November is at present regreding. This would make the passage occur somewhat earlier, and it seems not unlikely that the maximum display will occur some time before sunrise on the morning of November 14th. The beginning of the display may be looked for several hours earlier.

Jupiter was seen without satellites by several observers on the evening of August 21. The only noteworthy fact we hear of in connection with this phenomenon, is the observation that the shadow of the fourth satellite appeared larger than that of the third, though the third is the larger satellite. This observation, if confirmed, would show that the apparent dimensions of the shadow depend rather on the extent of the penumbra than of the true shadow.

Mr. Proctor has obtained a new determination of Mars's rotation-period. Mädler's determination, founded on seven years' observations, makes the period 24h. 37m. 23·8s. Kaiser extending his calculations over a longer interval obtained 24h. 37m. 22·6s. Mr. Proctor's determination combines observations by Hooke in 1665, by Sir W. Herschel in 1783, and by Dawes in 1864. The result is a period of 24h. 37m. 22·75s., with a probable error of one-fiftieth part of a second.

Mr. Stone has formed a table exhibiting the probable dimensions of seventy-one asteroids. On the assumption that their surfaces have equal reflective powers, the apparent brilliancy of these objects enables us to determine their relative dimensions. Mr. Stone then converts these results into miles by adopting the diameters of Ceres and Pallas resulting from the observations of Sir W. Herschel and Lamont. We append the diameters of the five largest and of the five smallest asteroids:—

Vesta	214 Miles.	Themis . . .	24 Miles.
Ceres	196 „	Asia	22 „
Pallas	171 „	Maia	18 „
Juno	124 „	Atalanta . . .	18 „
Hygeia	103 „	Echo	17 „

Mr. Huggins has been able to analyze the light of another comet with the spectroscope. On May 4th and 8th he made observations of Comet II, 1867. In the telescope the comet appeared to consist of a slightly oval coma, surrounding a minute and not very bright nucleus. The latter was not central, but nearer to the following edge of the coma. The light of the coma formed a continuous spectrum. Mr. Huggins was unable, on account of the faintness of the nucleus, to distinguish with certainty the spectrum of its light from the broad spectrum of the coma on which it appeared projected. Once or twice he suspected the presence of two or three bright lines, but of this observation he was not certain. He considers that this small comet is probably similar in physical structure to Comet I, 1866.

Mr. Peters, of Hamilton College Observatory, Clinton (U.S.), has discovered another small planet, the sixth of his discoveries, the 92nd asteroid, and the 100th primary member of the solar system.

It has been discovered by Mr. Buckingham that the brilliant Vega, long known as a wide optical double, has two minute companions. Whether we are to look on Vega as a true triple star remains as yet undetermined.

PROCEEDINGS OF THE ASTRONOMICAL SOCIETY.

Mr. Airy discusses the curious but annoying tendency which is occasionally seen in the telescopic discs of stars to become triangular, when the wind is in the east or south-east. Mr Dawes's observations suffice to show that the peculiarity does not depend on the object-glass of the telescope. Mr. Airy is disposed to refer the phenomenon to the derangement of the nervous system which usually accompanies an east wind. In a remarkable instance mentioned by Mr. Dawes, east wind and fatigue were combined. Mr. Dawes himself, however, considers the phenomenon to be certainly independent of the observer; a view coincided in by Captain Noble, who rejoices in the digestion of an ostrich, but yet has been troubled by "triangular nights."

Another subject, touched on by the Astronomer Royal, is dealt with more at length by Captain Noble. We refer to the alleged change of focus required in observing stars widely separated in altitude. Captain Noble's observations appear to show that in the very finest observing weather no change of focus is required. But when, as is usual, there is an appreciable amount of vapour near the horizon, it becomes necessary to shorten the focus of a telescope directed to low objects.

Mr. C. Piazzi Smyth, Astronomer Royal for Scotland, supplies an abstract of a paper on the earliest provable traces of good practical astronomy. He arranges ancient buildings into three classes:—

1st. Those which have no definite astronomical position.
2nd. Those which are oriented so as to have the *diagonals* of their bases towards the cardinal points.
3rd. Those which are oriented so as to have the *sides* of their bases towards the cardinal points.

The diagonal method prevailed in Mesopotamia, and its most splendid example is the temple of Nebo (devoted to all the Planets) at Babylon. The direct form characterizes the Pyramids. Smyth finds by comparing his own measures of the Great Pyramid with Sir H. Rawlinson's measures of the Nebo building, that the former, though 1,500 years older, is oriented sixty times more accurately than the latter.

Major Tennant supplies a paper "On the Expansion of Brass Pendula used in the Indian Trigonometrical Survey." These pendula were swung in a vacuum apparatus, at a very low pressure of atmosphere. There is an anomaly in the results, which would appear to show that at a pressure of only 5 inches of mercury the coefficient of expansion of the brass pendulum must be not only increased, but is actually 13 per cent. greater than has ever before been assigned to brass. It would be singular if it should appear that the size of a solid may, under certain circumstances, be subject to a variation due to pressure alone.

Messrs. De la Rue, Stewart, and Loewy discuss some recent observations and remarks of Hofrath Schwabe's regarding sun-spots and other solar phenomena. Schwabe notices certain phenomena on the surface of the sun, which he has noticed since last December, and which he remembers to have before observed, but only at the time of a minimum in the number of sun-spots. The phenomena are:—1st, a total absence of faculæ or faculous matter; 2nd, the absence of the usually observed scars, pores, and similar appearances; 3rd, an equal brightness of the whole surface, the limb being as luminous as the centre. At Schwabe's request the observations made at the Kew Observatory were carefully gone over. It was noticed that the phenomena occur only in years of minimum spot-frequency. Schwabe is disposed to trace a connection between sun-spots and meteoric showers; and it certainly happens that the two epochs at which the phenomena he describes have been presented, coincided with the great shooting-star showers of 1866 and 1833. It also happened that in the year 1848, which is the middle of the 33·25-years period there was a maximum of spots. But it does not seem easy to reconcile the eleven-years spot-period with the 33¼-years shower-period. If there had been a steady increase of spots from 1833 to 1848 and then a decrease to 1866 there would have appeared to be some foundation for Schwabe's theory, but as there occurred a minimum of spots in 1844 and another in 1855, we can understand that Messrs. De la Rue, Stewart, and Loewy should not regard Schwabe's views with favour. They record that on February 12th, 1844, and from June to August, 1855, the sun was without spots or faculæ.

Professor Brayley points out the importance of the spectroscopical examination of the vicinity of the sun when totally eclipsed, for the determination of the nature and extent of its luminous atmosphere. He considers that this atmosphere is partially identical with the Zodiacal Light, and he suggests that an attempt should be made to determine the true nature of the Zodiacal Light by means of spectrum analysis.

Professor Brayley adds that he has arrived at the conclusion that in all probability the bright-line or monochromatic spectra, from which Mr. Huggins has inferred the gaseous constitution of certain nebulæ, are in reality due to the luminous atmospheres of their constituent stars or suns. We believe that Mr. Huggins has already considered this view, and shown it to be inconsistent with known laws.

Mr. Stoney supplies a paper "On the Connection between Comets and Meteors." In January last M. Leverrier pointed out that the streams of meteors which produce star-showers must have been in compact clusters when they underwent the great perturbations which brought them into permanent connection with the solar system. And Mr. Graham has shown that the meteoric iron which reaches the earth must have been at some previous time red-hot; and that when last red-hot it was acted on by hydrogen under considerable pressure—a pressure of perhaps six or more atmospheres. Mr. Stoney makes use of these inferences in the endeavour to trace what the physical connection between comets and meteors has been. We must point out one important point in which his argument fails. He lays great stress on the difference between the assumed period of the November shooting-star system and the period of Tempel's comet; the former 33·25 years and the latter 33·18 years. In fact, his argument seems to require that some such difference should exist. But in the first place it is well known that the period of 33¼ years assigned to the meteors by Adams and Leverrier was never meant for more than a first approximation, and that a period of 33·18 years would account quite as well for all the phenomena yet observed. In the second place, we have no assurance that 33·18 years is the exact period of Tempel's comet. This is Dr. Oppolzer's determination, but other calculators obtained different results. We have assuredly no evidence that the difference of ·07 years between the periods of the meteor-stream and comet is one that can be insisted upon.

Professor Masters, of Kishnaghur College, Bengal, describes a shower of meteors seen at 2 A.M. on December 12. They shot divergingly and with great rapidity from a point situate in about 136° of right ascension and 29° or 30° of north declination.

Mr. Stone has estimated the longitude of the Sydney Observatory from observations of the moon and moon-calculating stars made in the years 1859 and 1860. His result gives for the difference of time between Sydney and Greenwich, 10h. 4m. 47·32s.

4. BOTANY, VEGETABLE MORPHOLOGY, AND PHYSIOLOGY.

ENGLAND.—*A Handy Book for Collectors of Cryptogams.*—The Rev. W. Spicer has translated, and Mr. Hardwicke has published, a little book on Cryptogams, by Johann Nave, which we feel sure must be very useful to those who wish to study and collect these plants. Methods of preparing and collecting Marine Algæ, Diatoms, Desmids, Fungi, Lichens, and Mosses are given in great detail. Strange instruments to be used in tearing or raking up sea-weeds are figured and described, and all the various appliances in favour with collectors of Diatoms and Desmids are brought before the reader. Twenty-six neat little plates, containing drawings of the most striking forms of the plants to which the volume is dedicated, are dispersed through its pages. The book is in size small enough for the pocket, and may fairly be recommended to all who are in want of instruction in the somewhat difficult and careful manipulation required in order to preserve specimens of Cryptogamic plants.

Sowerby's English Botany.—The new, greatly enlarged, and revised edition of this celebrated work, now being published under the direction of Mr. Boswell Syme, with popular descriptions of plants by Mrs. Lankester, has come to the conclusion of its seventh volume. Nearly four-fifths of the British Flora have now been completed, the last part issued finishing with the Amarantaceæ. Whilst this is going on, Professor Babington, of Cambridge, is supervising the issue of a supplement to the previous edition of 'Sowerby's Botany,' which is to contain descriptions and figures of all the species of plants recognized as British since the issue of the original work. Mr. Salter, late of the Geological Survey, is executing the plates, and Professor Babington's name is a guarantee for the letterpress. There appears to be some difficulty in obtaining subscribers for this supplement, which, however, we can heartily commend.

The Botanical Department of the British Museum.—The principal business of the department during the past year has, we learn from the report, consisted in the re-arrangement (with very large additions) of the general collection of *Algæ*, of the extensive order of *Euphorbiaceæ*, of the *Lycopodiaceæ*, *Nymphæaceæ*, and of a portion of the *Compositæ*. Also in the naming, arranging, and laying into the general Herbarium of the remainder of Mr. Charles Wright's extensive collections made in Cuba and New Mexico; of the extensive collection formed by the late Mr. David Douglas, in North Western America and California; of a large number of Ferns, collected in Ceylon by Mr. Thwaites, in Venezuela by M. Moritz, and in English gardens by Mr. John Smith; of *Piperaceæ*, from various collections; of Dr. Wallich's collection of Nepalese Oaks; of numerous plants from Brazil and from the Arctic regions; of palms from various regions; of numerous European collections, and of several important collections of Cryptogamic plants, including American and other Mosses. Also in the examination and arrangement of the valuable collection of *Cycadeæ*, presented by Mr. James Yates; of plants from the Tyrol; Ferns purchased from Mr. John Smith, of Kew; of fruits of *Capuliferæ* and *Coniferæ*, in the general fruit collection; of recent and fossil woods; and of the late Dr. Greville's very extensive and important collection of *Diatomaceæ*. Altogether, this seems not a bad year's work, but those who know the vast stores of hay packed away in the recesses of the Botanical Department of the British Museum will feel that even thus they may never live to see the national Herbarium arranged throughout.

Quinine Plants in India.—"It is a good thing that India seems likely to be able to supply the whole world with quinine, for not only was the American supply uncertain, it was actually threatened with extinction, owing to the reckless way in which the Indians killed the trees in the process of stripping, planting of course no new ones. Mr. M'Ivor, who has been ably seconding Mr. Clement R. Markham's efforts at chinchona planting, finds that by removing only one long strip of bark and immediately covering the wound with moss the bark is renewed, provided the cambium be not injured. The new bark, moreover, is thicker and richer in alkaloids than the original one. Indeed, Mr. Broughton, the newly appointed 'quinologist' at Ootacamund, tells us that the average yield of cultivated plants is nearly two per cent. higher than that of the wild American samples—7 per cent. instead of from 4·16 to 5·66 per cent. The only drawback is that the kind which grows most freely in India is the red bark, the quinine from which is usually mixed with a considerable portion of chinchonidine and other allied alkaloids, along with resin and colouring matter not easily separable. Still, however, since we shall use probably more and more quinine every year, it is better to have the mixture than none at all. Mr. Broughton suggests that these 'amorphous alkaloid substances' may have virtues of their own; but possibly, with more perfect processes, they may be found separable. Anyhow, it is better to take what India can give us for dispensary use, than to prepare (as they do in some dispensaries) their *mistura quiniæ* out of concentrated infusion of quassia and calumba, with a dash of aromatic sulphuric acid."

It is reported that Mr. Clement R. Markham is to join the Abyssinian expedition in a civil (scientific?) capacity.

FRANCE.—*Monstrosities becoming New Species in Plants.*—M. C. Naudin, in a late number of the 'Comptes Rendus,' mentions some very remarkable cases of this phenomenon, which have, of course, a very close bearing on Darwin's hypothesis. The first case mentioned is that of a Poppy (*Papaver officinale*), which took on a remarkable variation in its fruit—a crown of secondary capsules being added to the normal central capsule. A field of such poppies was grown, and M. Göppert, with seed from this field, obtained still this monstrous form, in great quantity. Deformities of Ferns are sometimes sought after by fern-growers. They are now always obtained by taking spores from the abnormal parts of a monstrous Fern, from which spores Ferns presenting the same peculiarities invariably grow. Some facts with regard to gourds are mentioned, but the most remarkable case is that observed by Dr. Godron, of Nancy. In 1861 that botanist observed, amongst a sowing of *Datura tatula* (the fruits of which are *very* spinous), a single individual of which the capsule was perfectly smooth. The seeds taken from this plant all furnished plants having the character of this individual. The fifth and sixth generations are now growing without exhibiting the least tendency to revert to the spinous form. More remarkable still, when crossed with normal *Datura tatula*, hybrids were produced which, in the succeeding generation, reverted to the two original types, as true hybrids do. M. Naudin is not very happy in his remarks upon these highly interesting facts. He urges that they give reason to believe that the origin of species by transmutation has not been a very slow process of natural selection; but rather that monstrosities have been produced right and left, according to the Lamarckian speculation.

GERMANY.—*The Potato.*—A wealthy citizen of Berlin has applied to the municipality of that town for a site on which to erect a statue of Francis Drake, as the introducer of the potato into Europe, and offers to subscribe 2,250*l.* towards the statue. This seems an easy way of settling the doubt lingering about the early history of the potato, and to which the corrupted Spanish name which the plant bears in English, and the corrupted Italian it bears in German, or the unmeaning French and Dutch ones, give no clue.

The Colouring Matters of Algæ.—Dr. Cohn, in a paper to which we recently referred, has distinguished two bodies soluble in water, the one found in *Phycochromaceæ*, the other in *Florideæ* in conjunction with Chlorophyll, to the first of which he gives the name Phycocyan, and to the second Phycoerythrin. These remarkable bodies give very distinct absorption-bands when examined by means of the spectroscope, and are also highly fluorescent, Phycocyan giving a fine carmine reflection, whilst the light it transmits is pale blue, and Phycoerythrin giving a yellow fluorescence, and transmitting the red rays. At a recent meeting of the Microscopical Society of London, Mr. Sheppard exhibited a fluid, having the properties of a solution of Phycocyan, which he had obtained from a vegetable growth in a spring in Kent. He contended that the colour was produced by the action of monads on albuminous substances which he had placed in the water with the vegetable matter. It appears, however, that the vegetable encrustation abounded in Oscillariæ, *Batrachospermum*, &c., and from the drawings and description given of the spectrum of the fluid and its fluorescence, there is no doubt that he had simply obtained a solution of the Phycocyan of Dr. Ferdinand Cohn. The colouring matters of the lower forms of plants and their relations to Chlorophyll and the physiology of plant-life form a very important and almost unexplored field of research.

5. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

But few papers call for notice on this occasion. The subject of water-analysis continues to attract a good deal of attention; and additional interest has been given to the matter by the communications of Professor Wanklyn and Messrs. Chapman and Smith. The first-named gentleman read a paper on the subject at the last meeting of the Chemical Society, an abstract of which will be found in our report of the Proceedings of the Society. Several joint communications have also been made to the 'Laboratory' during the past three months.

The researches of the gentlemen named have been devoted to the determination of ammonia and matters capable of yielding ammonia; and their results differ widely from those of other experimenters. We are told, for example, that the waters we have hitherto been taught to consider the purest and best fitted for town supplies, such as Loch Katrine and Bala Lake water, contain a larger amount of albumenoid putrescible matters than the waters at present supplied to the metropolis. Thus, quoting from Professor Wanklyn's table which gives the results in "parts in 1,000,000, *i.e.* milligrammes in a litre," there is in—

DESCRIPTION OF WATER.	Ammonia, as such and as urea.	Albumenoid ammonia.
Water from Bala Lake	0·01	0·25
Loch Katrine, from main in Glasgow	0·02	0·13
Woodhead water supplied to Manchester	0·01	0·07
Thames water supplied to London by West Middlesex Company	0·01	0·064
New River	0·01	0·05

These results, it will be seen, differ very widely from those of Dr. Frankland, and the whole subject seems to require further investigation. The process by which Professor Wanklyn obtains the albumenoid ammonia will be found in the abstract of his paper.

While on this subject we may quote the directions given by J. Loewe for the separation of organic matters from a water.*

In the first place the water is boiled until all carbonic acid is expelled. Any deposit is then collected, washed, and boiled with distilled water, adding at long intervals crystallized chloride of ammonium as long as any odour of ammonia is given off. A solution of acetate of copper is then added as long as a precipitate is produced. This precipitate is decomposed by sulphuretted hydrogen, and the filtered solution is evaporated to dryness on a water-bath. The author has only obtained traces of organic matter in this way. The water separated from the precipitate produced by boiling is now concentrated, and when cold, acetate of lead is added. The precipitate is first washed with boiling water to remove chloride of lead, and then with hyposulphite of soda to remove sulphate; there then remains only the organic compound of lead. To secure all the organic matter the liquor decanted from the acetate of lead precipitate must be treated with sub-acetate of lead; this second precipitate will, besides the organic compound, contain oxy-chloride and sub-nitrate of lead. These being got rid of, the mixed lead precipitates are decomposed by sulphuretted hydrogen, and the solution is filtered and evaporated. It is said that the residual organic matter obtained by the author was free from nitrogen; but we are not told what water he examined.

W. Heintz† gives a method of determining the amount of solids, both organic and inorganic, which does not much differ from that usually employed by careful chemists. The author evaporates below 100° C. sufficient water to leave from 0·3 to 0·6 gramme of residue, which he then keeps at 150°, until no loss of weight is observed. This gives the total residue. He then gradually ignites in a platinum crucible—allowing only a part to come to a red heat—until the residue is white, then moistens with solution of carbonate of ammonia, dries at 150°, and reweighs. The difference is very nearly the weight of the organic matter. But as the carbonate of magnesia will have undergone some alteration, to be exact, the author determines the carbonic acid both in the first and second residues, and adds the difference to the second weighing, thereby reducing by so much the organic matter. Heintz states that this method only gives accurate results when the magnesia is present in an organic combination, and when the water is not strongly charged with the oxides of iron and manganese, whose state of oxidation may be altered by the ignitions. The presence of chloride of magnesium is also a source of error, as all chemists will understand.

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* 'Zeitschrift für Chemie.' New Series, V. ii., p. 595; and 'Bulletin de la Société Chimique de Paris,' June, 1867, p. 497.

† 'Zeitschrift für Chemie.' New Series, V. ii., p. 586.

In technical chemistry one noteworthy fact is the process invented by M. Paraf-Javal, for the Transformation of Liquid into Solid Fats. It was known that under the influence of a strong alkali oleic acid splits up into acetic and palmitic acids This fact the inventor applies industrially as follows:—He heats one part of oleic acid with two or three times its weight of hydrate of potash almost to the fusing point of the potash. A large amount of hydrogen is disengaged in the reaction that ensues, and a porous, swollen mass results. The sudden collapse of this mass indicates that the reaction has ended. Water is now added in small quantities, so as to obtain a strong alkaline solution in which the soap formed is insoluble. The soap can thus be separated, and the greater part of the alkali recovered. When separated the soap is dissolved in water and afterwards precipitated by common salt. It is then decomposed by treatment with an acid, and the palmitic acid is purified by distillation. The liquid from which the soap is separated will, of course, contain an acetate of the alkali. This can be separated and the acetic acid obtained by means known to all chemists. Soda, it is said, may be used in place of potash. It is right to say that this process has been patented in France.

A method of obtaining caustic baryta cheaply is a great desideratum; and we give one recently published by M. Tessie du Motay, which, however, we fear is not likely to receive an extensive application. The inventor takes carbonate of baryta, mixes it into a paste with fat resin and charcoal, and burns the mixture in a reverberatory furnace. In this way the carbonate is reduced and the baryta is left mixed with some charcoal. The latter is burned away by passing a current of oxygen through the furnace, and the heat developed in this operation is so great as to prevent the recombination of the baryta with the carbonic acid produced. Baryta thus obtained is to be converted into peroxide of barium to furnish peroxide of hydrogen for bleaching purposes.

A new kind of artificial stone invented by M. Sorel deserves a passing notice. A strong solution of chloride of magnesium will consolidate a large amount of calcined magnesia, forming an insoluble oxychloride of magnesium, resembling the oxychloride of zinc proposed by the same inventor for stopping teeth. When, however, a weaker solution of the chloride of magnesium is used with some calcined magnesia, the mixture has the power of holding together fifteen or twenty times its weight of sand and other materials which set into a substance sufficiently hard to be used for flags and tiles, and which may be coloured by ordinary mineral colours for ornamental purposes.

The space we have in this number only allows the mention of the publication of useful practical papers "On the Analysis of Cast Iron," by Dr. G. E. Tosh;* and also "On the Practical Losses of Sulphur in the Manufacture of Oil of Vitriol," by Mr. C. R. A. Wright.†

PROCEEDINGS OF THE CHEMICAL SOCIETY.

On the 6th of June, Sir B. C. Brodie delivered a lecture to an unusually large audience, "On the Mode of Representation afforded by the Chemical Calculus, as contrasted with the Atomic Theory." For this lecture and the interesting discussion which followed it we must refer our readers to an admirable report in the 'Chemical News' for June 14. And those who wish to see the opinions of some other chemists, mathematicians, and physicists on Sir B. C. Brodie's system may consult the papers of Professor Williamson and Mr. Stanley Jevons in the 'Laboratory;' and the articles of Professor Wanklyn and Dr. Crum Brown, in the 'Philosophical Magazine' for August and September.

The last meeting of the Society was held on June 20, when Mr. W. H. Perkin read a paper "On some new Derivatives of the Hydride of Salicyl;" Dr. Gladstone read a second paper "On Pyrophosphoric Acid;" Dr. Phipson gave an "Analysis of a Biliary Concretion found in a Pig, and a new Method of preparing Biliverdin;" Dr. Stenhouse made a communication on the action of Chloride of Iodine on Picric Acid; and Mr. Henry Bassett read a short paper "On Julin's Chloride of Carbon." A paper by MM. J. A. Wanklyn, E. T. Chapman, and M. H. Smith, "On Water-analysis: Determination of Nitrogenous Organic Matter," was also read. As the subject of this paper is of great public interest we give a short abstract. The peculiar feature of the method is the estimation of the amount of nitrogenous organic matter by the amount of ammonia which is actually formed by distillation with carbonate of soda, caustic potash, and permanganate of potash. Direct experiments have shown that all the nitrogen in urea, gelatine, and albumen are obtainable in the form of ammonia by the method of treatment described; and has disclosed, the authors say, the singular fact that boiling with a caustic alkali liberates one-third the nitrogen of albumen and gelatine in the form of ammonia, and that a subsequent boiling with permanganate of potash liberates the other two-thirds. Thus the nitrogen of urea is obtainable as ammonia by boiling with carbonate of soda; and that of albumen by the caustic alkali and permanganate. We have therefore the means of distinguishing between ammonia from the two sources. The method pursued is briefly as follows: Free ammonia is first estimated in the water by Nessler's test, as described by Dr. Miller. A litre is then distilled with a little carbonate of soda. In this distillate will be found the ammonia from urea. The distillation is interrupted when ammonia ceases to pass, and caustic potash being added to the contents of the retort the distillation is again proceeded with. In the distillate now collected there will be ammonia representing one-third the nitrogen in the albumenoid matters in the water. The distillation is again interrupted and crystals of permanganate of potash are added, enough to give a deep violet tint, and once more the distillation is continued, now almost to dryness. This final distillate will give the remaining nitrogen in the form of ammonia. We must add that all the estimations of ammonia in the various distillates are made with Nessler's test-liquor. For quantitative examples of the method we must refer our readers to the original paper, published in the 'Journal of the Chemical Society' for September.

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* 'Chemical News,' Aug. 9 and 23, 1867.

† Ibid., Aug. 23 and 30.

6. ENGINEERING—CIVIL AND MECHANICAL.

We have, this quarter, to chronicle a more than usual extension of open lines of railway, some of which, too, are of the first importance.

In August last, two new Welsh railways were opened. The one from Aberystwith to Carmarthen, which, by completing a link in the western chain of railways running through the principality, opens the new route between the manufacturing districts of South Lancashire and the mineral districts of South Wales. The other—the Cambrian Railway—affords an unbroken route between Aberystwith and Carnarvon.

In India, the extension of the East India Railway from Allahabad to Jubbulpoor was opened on the 2nd May last. The only gap now remaining in the line from Bombay to Calcutta is between Khundwah and Jubbulpoor, which, it is expected, will be completed by May, 1868. In the Punjab the line from Umritsur to the Beas has just been opened, as has also a branch railway between Lucknow and Cawnpore in Oude. The East India and the Great Indian Peninsular Railways are busily engaged in laying down a second line of rails on portions of their lines; and the usual government guarantee has been given to the Indian Branch Railway Company for the construction of 672 miles of light railways in Oude and Rohilcund.

On Monday, 26th August, the first engine and train passed over the Mont Cenis Railway from St. Michel to Susa, a distance of 48 miles. The summit crossed is at an elevation of 6,700 feet above the level of the sea, which is attained by a series of steep inclines, worked on Mr. Fell's central rail system.

The Brenner Railroad, between Innspruck and Botzen, has recently been opened for traffic, thus establishing a direct connection between Italy and Central Germany. The summit of the Brenner Pass is 4,484 feet above the sea level.

At Stutgard a new railway terminus has been opened, and a series of small branches intended to complete the railway network of Wurtemburg, have been completed. The Eastern Railway of France has added to its system a section, 28 miles in length, from St. Hilaire au Temple to St. Menehould. This company has now 1,630 miles of railway open. The length of railway in operation in Prussia at the close of 1866 was 5,762½ miles, which had been completed at an expenditure of 90,000,000*l*.

The Pacific Railway, intended to connect the railroad system of the United States with California, and which is now under construction, will, in connection with the other lines of railway already completed, cross the Continent in a direct line from New York on the Atlantic, to San Francisco on the Pacific Ocean, having a total length of 3,300 miles.

The fourth of the six great lattice girders, intended to form three spans, of 300 feet each, over the Mersey at Runcorn, was let down to its bearings on June 11th. This bridge will carry the London and North-Western Railway by a direct line to Liverpool. The last girder is expected to be in its place by Christmas next.

The Dutch government has determined on the construction of the Mærdyk bridge, between Mærdyk and Willemsdorf. This work, which will be 1½ miles in length, will directly unite the railway network of the Low Countries to the Belgian and French lines.

The Cincinnati Suspension Bridge, U.S., which has recently been completed, has a clear span between the centres of towers of 1,057 feet, and is the longest suspension span yet executed. The

Susquehanna bridge, at Havre de Grace, U.S., is now nearly completed. It is being constructed to unite the hitherto severed portions of the Philadelphia, Wilmington, and Baltimore Railroad. The superstructure, which is for a single line, is of wood, built on the Howe plan, with arches, and consists of twelve spans of 250 ft. 9 in., and a draw span of 174 ft. 9 in. The whole distance between the abutments is 3,273 ft. 9 in. Arrangements are in progress for building a second suspension bridge across the Niagara. This new bridge will be much larger than its neighbour below, the clear span of which is 822 feet.

The East India Irrigation and Canal Company has at last been entrusted with the carrying out of a system of irrigation from the Soane River, in the lower Provinces of Bengal. Had this work been undertaken when it was first designed by Colonel Dickens, much of the past and present calamities of famine in those districts might have been averted.

A prospectus has been issued of the Valparaiso Waterworks Company, to supply that city with water through a canal to be cut from the Aconcagua river, flowing from the Andes. This canal, a portion of which has already been completed, is at the same time calculated to yield a revenue by furnishing water for irrigation to the lands throughout its course.

Three companies have recently been started for establishing a through line of telegraph between England and India. The lines of one company are proposed to pass through France, Italy, Sicily, Malta, Alexandria, and Suez, to Bombay; whilst another would pass through Prussia, Russia, Persia, and along the Persian Gulf to Kurrachee. The third company—which we believe has amalgamated with the first—proposed to carry independent lines from Falmouth to Gibraltar, Malta, &c.

A contract has been concluded for the manufacture of a new cable, to be laid by the Submarine Telegraph Company, between England and Belgium.

Both the shore ends of the Florida and Cuba cable were successfully laid early in August last, but just as the splice was about to be made, the cable suddenly parted about half-a-mile east of the buoy, and the ends sank into the sea.

The foundation stone of the Holborn Valley Viaduct was laid on Monday, June 3rd. Within the past century a total sum of 6,742,853*l.* has been expended by the Corporation of London on public works, buildings, and street improvements.

The American life-raft, which recently crossed the Atlantic in forty-three days, is formed of three cylinders, charged with air and connected by canvas, stiffened by planking. She is 24 feet long, 12½ feet broad, and carries two masts.

A company has been formed to remedy the obstacles which the bar of the Mississippi offers to navigation. The system which this company proposes to apply to the relief of ships consists of an apparatus of caoutchouc, forming a kind of floating dock, which will be manœuvred with the aid of two tugs. The company hopes by this means to raise to the extent of 8 feet ships drawing 20 feet of water, and to enable them to go over the bar in less than three hours.

The drainage works of Eastbourne have recently been completed and opened.

On the subject of docks, &c., we have to report the admission of water into the Millwall Docks, on the Thames, on 29th August last. On the 1st idem, the first stone of the new graving dock at Malta was laid; this dock, when completed, will be the largest ever constructed, its dimensions being—length, 468 feet; width, 104 feet, and depth, 39 feet. A new slip dock has recently been opened on the Clyde, capable of taking in ships of 2,000 tons; it is 850 feet long, and 57 feet broad. A new floating railway pier at Burntisland, which has been under construction for the past two years, has just been completed. The pier commences about 330 yards east of the Burntisland passenger station, and extends for 1,000 feet in a south-westerly direction, thus forming a harbour which is accessible at all states of the tide.

A process is now being carried out by Messrs. Whitworth, of Manchester, of subjecting steel to a high pressure during the process of casting; the object being to obtain sounder castings, and to do away with the necessity for great "heads" of metal. Mr. Whitworth is also endeavouring by hydrostatic pressure to effect the rolling, or otherwise shaping, under pressure, of cast-steel in the liquid state. Mr. A. L. Holley, of Harrisburg, U.S., has recently patented a plan for casting Bessemer steel ingots from the bottom instead of from the top as is usual; and it is found that ingots thus cast are square and sound at the top as well as at the bottom, and they are more free from cracks and external honeycombs, and much smoother than ingots cast from the top.

A new form of tyre-lathe has recently been introduced by Messrs Greenwood, of Leeds, which has been designed to facilitate the boring of railway tyres, by enabling the whole operation to be completed without shifting the work in the machine, the arrangement being such that cutting tools can be simultaneously brought into action on the opposite faces of the tyre, and also on its inner surface.

7. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

The energy of the Secretary of the Palæontographical Society (the Rev. T. Wiltshire) has borne fruit in the appearance this quarter of another volume of the Society's Monographs,—that for 1866,—after an interval of only six months from the date of publication of the one we last noticed.

This volume opens with a second instalment of Dr. Duncan's Monograph of the British Fossil Corals, in which are described the Zoantharia from the Liassic zones of *Ammonites planorbis* and *A. angulatus.* These zones have recently been the subject of much discussion, especially as regards their more or less close relationships with those above and below. We have recently given a summary of Dr. Duncan's interpretation of the coral evidence, in recording the publication of his paper "On the Madreporaria of the Infra-Lias of South Wales," so on this occasion we shall confine our attention to some of the author's considerations on the philosophy of zone classifications generally. The Liassic and Oolitic formations have been subdivided into a number of "zones," each of which is characterized by, and named from, the occurrence of a certain species of Ammonite. The more enthusiastic advocates of this classification seem to believe that the range of other organisms is more or less co-extensive with that of the Ammonites, and that the latter, being abundant in these deposits, and tolerably easy of determination, afford the *easiest* means of identifying the zones; it has also been stated that they are the *best* test of horizons, because their range is less uncertain than that of other organisms. Dr. Duncan's researches into the distribution of the Liassic Corals have not enabled him to strengthen the arguments in favour of zone classifications; on the contrary, he has been led to the conviction that "the endeavour to give definite horizons to, and to correlate, *Saurian, Insect, Ostrea, Ammonite,* and *Lima* beds has resulted in the production of confusion instead of the reverse;" also "that no stratigraphical Palæontology can be perfect in a classificatory sense, and that *zones of species may have little to do with the notion of time.*"

Holding this opinion the author's practice may appear inconsistent with his preaching; but in reality he accepts the principle of a zone-classification in a modified sense. "The groups of Madreporaria have a general relation to certain zones of life and to certain strata; and if they are associated for the sake of a necessary classification with certain Ammonite-zones, it must be understood that it is only an approximative classification, and that both the

Ammonites and the Madreporaria may range out of their supposed restricted zone, or not even be represented in certain portions of its area." In point of fact, Dr. Duncan is one of the few palæontologists who can view the birth and death of the life of a period as symbolized by a line that is elastic, and not rigid.

Mr. Salter's contribution to this volume, being Part IV. of his Monograph of British Trilobites, consists almost entirely of descriptions of the species of the genus *Illænus* and of its subgenera; Mr. Davidson continues his description of the Silurian *Spiriferidæ* and commences that of the *Rhynchonellidæ*; and Professor Phillips makes considerable progress in the description of the Liassic Belemnites.

The volume is illustrated by forty well-executed plates, which are mostly beautiful specimens of scientific lithography, some being English and some French.

The most recent publication of the Geological Survey of India, another contribution to Indian Palæontology,* is a work of more than Indian importance. It contains the first portion of Dr. Stoliczka's description of the Gasteropoda of the Cretaceous rocks of Southern India, including the Pulmonata and the siphonostomatous Prosobranchia; but its general interest will be due to its containing an elaborate essay on the classification of the Gasteropoda—the illustrative examples being necessarily chosen from the Cretaceous fossils of Southern India. It will be sufficient for us to mention here that Dr. Stoliczka's plan is to subdivide the old generic groups, such as *Fusus*, *Murex*, &c., into a number of smaller groups which he considers to be still of generic value. Although, in this course, Dr. Stoliczka has to some extent followed many able conchologists, the plan has not yet found much favour with British palæontologists.

The Journal of the Royal Geological Society of Ireland contains several meritorious papers on drift deposits and theories of denudation. Our space will not admit of our giving analyses of these memoirs; but we may especially draw the attention of our readers to Mr. G. H. Kinahan's "Notes on some of the Drift in Ireland;" and to a very elaborate essay by the Rev. Maxwell H. Close, "On the General Glaciation of Ireland."

In a communication to the Royal Institute of Lombardy,† Sign. Lombardini describes some traces of the Glacial period which he had observed in the great depression of Central Africa. He therefore infers that confirmatory evidence will be found in the mountainous districts of Abyssinia, and in the more southern and tropical regions of Kenia and Kilimandjaro. Collating his results with those of M. Reclus in the Sierra Nevada, and of M. Agassiz in Brazil, he comes to the conclusion that the phenomena of the Glacial period were spread over the whole surface of the globe.

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* Palæontologia Indica, vol. v., fasc. 1–4.

† Rendiconti del Reale Istituto Lombardo di Scienze e Lettere. Classe di Scienze Matematiche e Naturali, vol. iii., fasc. 3, p. 85.

These investigations have a direct bearing on the speculations of Mr. Croll and others, the basis of whose hypotheses is the assumption that the glacial phenomena were limited to extra-tropical regions. Mr. Croll, indeed, has recently published a modification of his original hypothesis to account for changes of climate, namely, alterations in the obliquity of the ecliptic; and has thus got into another controversy with his old opponent, Mr. J. Carrick Moore. The several papers which have been published on this subject will be found in the numbers of the 'Philosophical Magazine' issued during the past quarter.

The geological survey of the Grand Duchy of Hesse has recently made considerable progress; and several sheets of the map with descriptive memoirs have come under our notice. Amongst them we wish especially to draw attention to the map and description of the Section Alzey by M. Ludwig; and to those of the Section Mainz by Herr Grooss. These maps and memoirs furnish us with the most accurate descriptions yet published of two of the most classical of all the German Tertiary localities, and therefore deserve more than a local circulation.

The 'Geological Magazine' for the quarter has contained a large number of original articles, but we have space to notice only two or three of the most important.

In the first place we must draw attention to a paper by Professor King in the June number and an answer to it by Mr. Davidson in the July number, with a notice in the latter of a paper by Mr. Meek —all on the subject of the perforation or non-perforation of certain Palæozoic Brachiopoda. Dr. Carpenter has also taken part in the discussion, and has published papers on the subject in the January and July numbers of the 'Annals and Magazine of Natural History.' The chief cause of the discussion appears to be the rather remarkable fact that two forms of Spirifer (*S. cuspidatus*), though otherwise undistinguishable, are respectively characterized by the perforation of the shell in the one case, and its non-perforation in the other.

The August number of the Magazine is chiefly remarkable for containing a verbatim report of Dr. T. Sterry Hunt's lecture on the chemistry of the Primeval Earth, which was delivered at the Royal Institution on May 31st.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

An important paper by Mr. Tate "On some Secondary Fossils from South Africa," forms the commencement of the last number of the Society's Journal. It contains descriptions of a large number of fossils from the Mesozoic deposits of that region, and is enriched by much information on the stratigraphy of the district, brought together by Prof. T. Rupert Jones, F.G.S. The fossils were obtained from two series of deposits, namely, (1) the Karoo Beds, and (2) the Uitenhage Series; and they consist of plants from the former, and plants and shells from the latter. The Karoo Beds include a large series of deposits, the more recent of which (the Dicynodon-strata) have yielded the reptilian remains which have impressed a classical stamp on the South African region, as well as some of the plants now described. Mr. Tate infers their age to be Triassic, chiefly because, while the plants are undoubtedly Mesozoic, the strata are distinctly older than the Uitenhage Series above them.

The Uitenhage Series, which the author infers to be of Jurassic age, has yielded about half-a-dozen species of ferns and a few Cycads, besides nearly forty species of Mollusca, and is probably of the same date as the strata of the Rajmahal Hills and of Scarborough, which yield remains representing those from the South African strata. In the same way the plants from the Karoo beds present a close analogy with those from the Coal-formation of Eastern Australia, and the plant-bearing beds of Burdwan and Nagpur in India, the characteristic plant in all these deposits being a *Glossopteris*, apparently belonging to the same species.

The examination of so interesting a series of Lower Secondary fossils has necessarily led Mr. Tate to compare them with those obtained from the equivalent deposits in Europe, and he has come to the conclusion that while the Upper Trias of Europe presents a remarkable uniformity with its representatives in other countries, the Jurassic series—which is so fully developed in Western and Central Europe, and is reduced in the Mediterranean basin to the beds from the Lias to the Oxford Clay inclusive—in Russia constitute but one formation, and the extra-European developments of the series are more comparable with the Russian than the more Western type. He does not, therefore, regard these South African deposits as corresponding to any particular division of the Jurassic rocks, but considers them rather to represent the whole of the formation, with the exception of the Upper Oolites.

Mr. Boyd Dawkins contributes a second paper on the British Fossil Oxen, namely, on *Bos longifrons*, Owen, and arrives at the conclusion that although it has been found abundantly in the bone-caves and alluvia of the Pre-historic age, it has not yet been proved to have existed in earlier times. He also considers it to be the progenitor of the small Highland and Welsh cattle, and altogether an animal more nearly concerning the archæologist than the geologist.

A most interesting and carefully written paper, "On some Sea-water Level Marks on the Coast of Sweden," by the Earl of Selkirk, throws great doubt on the received creed as to the rise of land in Scandinavia; and although we cannot admit that his lordship has entirely disproved the belief that the land is gradually rising, he has no doubt done good service by showing flaws in the evidence sufficient to call into action more caution and discrimination on the part of future investigators, than has been exercised by many of those who have hitherto studied the subject.

In a paper "On the Lower Lias or Lias-conglomerate of a part of Glamorganshire," Mr. H. W. Bristow combats Mr. Tawney's conclusions as to the Sutton and Southerndown series, and shows that instead of the latter overlying the former, the two series pass horizontally into one another. Mr. Bristow's experience as a surveyor and Mr. Tawney's deficiency in this respect render it extremely probable that the interpretation of the sections now given is the correct one, and that the Sutton series is not quite so ancient as Mr. Tawney believed it to be.

Mr. J. W. Judd has a most creditable paper "On the Strata which form the Base of the Lincolnshire Wolds," in which he describes at length the various red .beds occurring in the Lower Chalk as distinguished from the Red Chalk of Hunstanton (the Hunstanton Limestone of Mr. Seeley), which is probably of the age of the Upper Greensand or Gault, possibly even representating both of these formations, as has been suggested by Mr. Seeley. Mr. Judd distinguishes by the name of the "Tealby Series" a still lower set of strata, the analogies of whose fauna are to be found in the Neocomian fossils of North-western Germany and South-eastern France, rather than in those of the Lower Greensand of the South of England. The geology of the Lincolnshire Wolds has been so much neglected that Mr. Judd has done the work of a pioneer, and, considering the slight information we formerly possessed on the subject, this paper gives a remarkably solid basis for future progress in correlating still more closely the strata of this district with those of other regions; and more especially in defining the relations of the Neocomian strata of the Continent with the English Lower Greensand.

Two papers on *Eozoon*, by Sir W. Logan and Dr. Dawson, contain a complete description of some specimens of that fossil, which consist entirely of carbonate of lime, as well as of the strata in which they were found. The discovery of the specimens of *Eozoon* in this condition is the best possible answer to some at least of the arguments used by Prof. King and Dr. Rowney against the organic nature of the fossil; and in addition Dr. Dawson states that the objections raised by them had been considered by him previously to publishing his first paper on the subject.

We have thus selected out of the Society's Journal some of the more important of the papers it contains; but several others are worthy of perusal by those interested in the subjects treated of, especially Mr. Boyd Dawkins's paper "On the Dentition of *Rhinoceros leptorhinus.*"

It is with sincere grief that we are compelled to announce the death of Mr. W. J. Hamilton, F.R.S., F.G.S., who was one of the magnates of the Geological Society, having been twice its President, and Secretary for a number of years. For an account of Mr. Hamilton's career our limited space compels us to refer our readers to the August number of the 'Geological Magazine.'

8. MINERALOGY, MINING, AND METALLURGY.

Mineralogy.

The characteristic association of certain minerals or their *paragenesis*—to use a convenient term adopted in German science—is a subject deserving the most attentive consideration, whether for its theoretical value, or for its practical bearing on mining enterprise. It is, indeed, by the study of these associations, that we may hope to become acqainted with the conditions under which the minerals were formed; and, by the accumulation of a sufficient number of examples, may eventually be led to generalizations of great practical utility. Even with our imperfect knowledge of the laws of paragenesis, instances are not wanting of discoveries having been made by observing that the presence of one species, perhaps in itself of no value, points in many cases to the occurrence of another mineral which may be of considerable importance. With regard to a substance so highly prized as gold, these observations have, of course, especial interest; and our thanks are, therefore, due to Herr Credner for the painstaking way in which he has noted the different associations of gold that have fallen under his observation during a residence in the gold-fields of Georgia.* In many parts of this State the gold is accompanied by tetradymite or telluric bismuth, a mineral which is also found in our Welsh mines, and in many other gold-bearing districts. South of Dahlonega the metal occurs in a syenitic gneiss; and to the east of the same locality, it is found, with red garnets, in a chlorite-slate; tetradymite being an associate of the gold in both situations. The mode in which the metal occurs in Cherokee County is of considerable paragenetic interest: in the white talcose slate of that county there are found numerous oval concretions of mispickel or arsenical pyrites.

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* Beschreibung einiger paragenetisch interessanter Gold-Vorkommen in Georgia, Nord-Amerika. Leonhard und Geinitz's Neues Jahrbuch für Mineralogie, u.s.w. 1867, Heft IV., p. 442.

Externally these nodules are coated with brown iron-ore derived from the decomposition of the mispickel, whilst internally they are traversed by fissures, the walls of which are studded with crystals of scorodite and pharmacosiderite, associated with much native gold, partly in dendritic and moss-like forms, and partly crystallized in cubes and octohedra. Finally, the writer calls attention to the auriferous quartz of Burnt Hickory, S.W. of Ackworth, where the gold is found in association with brown iron-ore and native sulphur. Originally the precious metal doubtless existed in the form of auriferous iron-pyrites; and the decomposition of this mineral has yielded the sulphur and oxide of iron. The sulphur occurs in the cavities of the loose brown iron-ore, and in some cases assumes the form of crystals, pseudomorphous after those of iron-pyrites. To explain the decomposition of the mundic, with the formation of these products, Herr Credner follows the principle suggested long since by G. Rose, to account for similar phenomena in the gold-deposits of Beresow in the Urals; a decomposition which may be represented by the following equation:—

$$2\,\mathrm{Fe\,S_2} + 3\,\mathrm{HO} = \mathrm{Fe_2\,O_3} + 3\,\mathrm{HS} + \mathrm{S}$$

Professor Nordenskiöld's recent examination of the rich collection of seleniferous minerals in the Stockholm Museum, has led to the detection of small quantities of the rare metal thallium in certain specimens of eukairite and berzelianite, which were obtained some years ago from the copper-mine of Skrikerum in Småland. Associated with these two selenides, there occurs a third mineral, allied to the others in general characters, but distinguished by containing thallium to the extent of not less than 19 per cent. M. Nordenskiöld considers this mineral to be clearly separable as a distinct species, for which he proposes the name of *Crookesite*, as an appropriate honour to the discoverer of thallium, Mr. William Crookes, F.R.S.

Crookesite occurs in small opaque masses, having a vitreous lustre and a lead-grey colour, a hardness of about 3, and a specific gravity of 6·9. Before the blowpipe it colours the flame intensely green, fusing to a lustrous greenish-black enamel. In hydrochloric acid the mineral is soluble. It appears to be a selenide of copper, thallium, and silver; the silver, however, being referred to a trace of eukairite. The formula of Crookesite may be thus written:[*]—$(\mathrm{Cu_2}, \mathrm{Tl}, \mathrm{Ag})\,\mathrm{Se}$.

In the lignite, or brown coal, of Weissenfels, in Prussian Saxony, there occurs an earthy mineral-resin described some time ago by Professor Kenngott as *Pyropissite*. Of late years this substance has become of considerable economic value from its employment in the manufacture of paraffin. Towards the end of 1865 Herr Stöhr visited the locality, and has lately published the results of his visit in a long memoir,* describing the physical and chemical characters of the mineral, its geological position, and its probable origin. He believes that it has been formed by the alteration of brown coal, and not, as had been suggested, by the *Pinites succinifer*, or amber-yielding pine; for, although true amber occurs in the neighbouring rocks, yet the plant-remains found in immediate association with the pyropissite have no affinity whatever with those of the amber-tree.

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[*] Ofversight of Kongl. Vetenskaps-Akademiens Forhandlingar, No. 10; and 'Chemical News,' July 19, 1867, p. 29.

The French chemist, M. Mène, whose researches on iron pyrites were noticed in the Chronicles of last quarter, has communicated to the Academy of Sciences his "Analyses of various crystallized and amorphous Graphites."† This paper contains no less than forty original analyses, chiefly of the native mineral, but including also a few artificial graphites, and three analyses of plumbago crucibles. Although we do not observe that these investigations lead to any new deduction, yet original work of this kind, when carefully conducted, must always possess a certain value for comparison with the results obtained by other chemists.

In a short but suggestive paper "On Banded and Brecciated Concretions,"‡ Mr. Ruskin touches upon some obscure points of mineral structure, and treats them with his wonted originality of thought. We presume, however, that few mineralogists will be disposed to accept his conclusions without qualification. The banded structure exhibited by many minerals, such as agate, is commonly regarded as the necessary result of the manner in which the substance was deposited from solution, layer by layer; but Mr. Ruskin, not satisfied with this explanation, imagines that the concentric zones do not represent successive deposits, but that they are concretionary bands which have gradually separated from the surrounding mass, and have arranged themselves in definite form, each band presenting in many cases distinctive characters of its own. Further, instead of believing that in every brecciated structure some dislocating force has shattered the substance, and that the fragments have been afterwards cemented together, he conceives that in many cases—and notably in certain agates and marbles—the apparent brecciation results from the segregation of definite substances from an impure matrix, and the rending asunder of these concretions by subsequent contraction.

Prof. Kenngott, of Zurich, has forwarded to the 'Journal für praktische Chemie' some "Communications on Richmondite, Osmelite, and Neolite,"[*] and also "On Pyrophyllite, Hydrargyllite, Pennine, Chlorite, and Clinochlore."[†] These papers are chiefly occupied by a collation of numerous analyses of the above-named minerals, and by attempts to deduce rational formulæ therefrom.

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* Das Pyropissit-Vorkommen in den Braunkohlen bei Weissenfels und Zeitz. Neues Jahrbuch für Mineralogie, u.s.w. 1867, Heft IV., p. 403.

† Analyses de divers graphites cristallisés et amorphes: 'Comptes Rendus,' 1867, n° 21, p. 1091.

‡ 'Geological Magazine,' August, 1867, p. 337.

A careful study of the minerals known as pholerite, nacrite, steinmark, and kaolin, has led Messrs. Johnson and Blake to the conclusion that these minerals are sufficiently related to justify their consolidation into a single species, for which they suggest the name of *Kaolinite*,[‡] since the substance is represented in its purest form by the basis of certain kaolins or china-clays. Kaolinite crystallizes in the rhombic system, and has a composition agreeing with that deduced by the late Prof. Forchhammer from his analyses of porcelain-clay, *viz.*—

$$3\,Al_2\,O_3, + Si\,O_3 + 6\,HO.$$

The brilliancy and variety of the tints presented by fluor spar have attracted the attention of M. Wybrouff, who has made them the subject of an elaborate series of investigations, partly chemical, and partly microscopical. These researches show that the fluor spars hitherto examined owe their colours to the presence of certain hydrocarbons, which in many cases have arisen from the decomposition of bituminous limestones. The author has given particular attention to a fetid fluor (Stinkfluss) from Wölsendorf in Bavaria, termed *Antozonite* in accordance with the supposition that it contains the so-called antozone. It may not be unnecessary to remark that Schönbein regards oxygen in its ordinary inactive condition as a compound of ozone, or negative active oxygen ($\bar{O}$), with antozone or positive active oxygen ($\overset{+}{O}$); the latter condition of the element is supposed to exist in the Wölsendorf fluor spar. Wybrouff, however, shows that the odour which this variety emits on friction proceeds, not from the presence of free antozone, but from the decomposition of the organic colouring matter. The connection between the colour and the odour is indeed clearly brought out by his microscopical observations, for which the reader must refer to the original paper.[§]

Herr Paulinyi, of the Mining School of Schemnitz, has communicated to the Academy of Sciences at Pesth, an account of a new mineral which he has recently detected in a brecciated specimen from a vein at Kremnitz, in Hungary. It occurs in cubic crystals of a black colour and a vitreous lustre, giving an uneven fracture when broken, and having a dull-green streak. The mineral, which has a very sweet taste, was found on analysis to have the following composition:—

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[*] 'Journ. f. Prakt. Chem.' 1867, No. 9, p. 6.

[†] *Ibid.*, p. 17.

[‡] "On Kaolinite and Pholerite:" 'Silliman's American Journal of Science and the Arts,' May, 1867, p. 351.

[§] Recherches microscopiques sur les substances colorantes des fluorine. Bulletin de la Soc. Imp. des Naturalistes de Moscou. Tome xxxix. p. 150.

Sulphuric Acid	45·32
Protoxide of iron	6·66
Peroxide of iron	44·92
Water	1·51
	98·41

From this analysis the following formula may be calculated:—

$$\mathrm{Fe\,O,\ SO_3 + 3\ (Fe_2\,O_3,\ 2\ SO_3) + HO}$$

The mineral is therefore a hydrous sulphate of the proto- and peroxides of iron; standing between iron-alum and voltaite, but related much nearer to the latter than to the former, yet differing from voltaite sufficiently to admit of its separation as a distinct species, for which Paulinyi proposes the name of *Pettkoite*, after Professor von Pettko.*

In a letter addressed to Professor Dana, and published in 'Silliman's Journal,'† M. Pisani expresses his belief that the mineral called Taltalite, by Domeyko, is only an accidental mixture of oxide of copper, with a fibrous tourmaline rich in iron.

Several analyses of new Swiss minerals have been lately published by Herr von Fellenberg; but, as our limits forbid any detailed notice, it must suffice to say that they relate to a new felspar, at first mistaken for a green talc; to a peculiar serpentine, containing only a small proportion of water; and to a variety of calcite, characterized by the presence of carbonate of strontia.‡

MINING.

The Mineral Statistics of the United Kingdom, which have just been issued from the 'Mining Record' office, make us acquainted with the present state of our mining industries. We shall endeavour to present, as concisely as possible, the condition of last year as compared with the preceding:—

In 1865 we produced—of	Tons.	In 1866 we produced Tons.
Coals	98,150,587	101,630,548
Iron ore	9,910,045	9,665,042
Tin „	15,686	15,080
Copper ore	198,298	180,378
Lead „	90‘451	91,047
Zinc „	17,842	12,779
Pyrites „	114,195	135,402
Gold Quartz	4,282	2,927

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* Leonhard und Geinitz's Neues Jahrbuch. 1867. Heft IV., p. 457.

† May, 1867, p. 407.

‡ 'Journal für Praktische Chemie,' 1867, No. 9 p. 32.

The quantities of the metals obtained from these ores were as follows:—

	1865.		1866.
	Tons.		Tons.
Iron	4,819,254	..	4,530,051
Tin	10,039	..	9,990
Copper	11,888	..	11,153
Lead	67,181	..	67,390
Zinc	4,040	..	3,192
	Ozs.		Ozs.
Silver from the lead	724,856	..	636,188
Gold	1,664	..	743

The total value of the mineral productions of these islands in 1866 is given as follows:—

Metals obtained from ores raised from the British mines	£14,954,695
Coals, estimated price at the place of production	25,407,635
Earthy minerals, not building stones	1,350,000
	£41,712,330

This and the last year have presented a depression in mining adventure which has not been equalled within the present century. All our mining interests have suffered to a greater or less degree, but the Tin and the Copper Mines of Cornwall and Devonshire have in almost every instance been worked at a ruinous loss. The result of this has been the emigration of more than seven thousand miners, the closing of a great number of mines, and the reduction of the work in many more. We learn from the 'Mineral Statistics' that tin ore in 1859 was 74*l.* 15*s.* per ton; whereas, in 1866, it was only 48*l.* 10*s.* 9*d.* The price of copper-ore has also fallen, it being, in 1859, 5*l.* 19*s.* a ton, and in 1866, 4*l.* 11*s.* There has also been a very steady falling off in the production of fine copper during that period.

In connection with mining for the precious metals, a most elaborate and eminently useful volume, 'The Mining and Metallurgy of Gold and Silver' in all parts of the world, has been produced by Mr. John Arthur Phillips, who is already well known by his 'Manual of Metallurgy.' We must content ourselves at present with this passing notice of the appearance of this splendid volume. Its importance is such that it demands from us a careful examination at an early period.

Several sets of experiments have been made on the different varieties of Safety Lamps in use in this country and in Belgium. One set was made some short time since at Newcastle, and more recently another set of similar experiments have been carefully carried out at Barnsley. The experiments in both cases consisted in exposing the safety lamps under trial to regulated currents of explosive mixtures of coal-gas and atmospheric air. When gas was made to travel through the box in which the lamps were placed, at the rate of 7·3 feet per second, all the lamps exploded—the ordinary Davy first, and the Stephenson last. In the recent experiments of Messrs. Hutchinson and Wilson, at Barnsley, where the coal-gas of the gasworks was used, it has been suspected that some of the results were due to olefiant gas in the explosive mixture employed. This would certainly render explosion more probable; but all the experiments teach us in an unmistakable manner that, as we have improved the ventilation of our coal mines, we have, by driving the currents of air more rapidly through the ways of a colliery, rendered that which was a safety lamp safe no longer, and the attention of the ingenious must be turned to the construction of a lamp which shall resist the action of currents of explosive gases travelling at from seven to ten feet per second. The results of these experiments promise us the production of a modified form of the Stephenson lamp, which will be a real safety lamp.

The Select Committee on Mining have made their report. They recommend that no boys should be employed in any mine under sixteen years of age, and that the hours of labour should be regulated so as to allow the proper time for rest and recreation.

The truck-system, still prevalent in some parts of the country, is to be repressed. Several new, and in some cases, it would appear, impracticable regulations as to the modes of working collieries are proposed. They also recommend that the present staff of inspectors should be increased—a recommendation to which there appears to be a very general objection, unless the system of inspection is extended far beyond what was originally contemplated by the legislature.

METALLURGY.

There is not much to report of novelty in any of our Metallurgical processes during the past quarter.

The Wilson downward-draught puddling furnace, which is in action at the Bolton Iron and Steel Company's works, is reported of as giving most excellent results. It is said to be producing a ton of puddled blooms to a ton of coal, and that without smoke, and with a minimum waste of metal. Twenty-one hundred weight and a half of pigs per ton of blooms has been reported. Further experiments are, however, necessary to establish this.

The Metallurgical methods of Messrs. Whelpley and Storer are receiving so much attention in the United States and in Canada, that some notice of them cannot but be interesting to our metallurgical readers. Dr. Sterry Hunt, F.R.S., of the Canadian Geological Survey, than whom there cannot be a more competent authority, has written very fully on those processes, and from his paper we select the following paragraphs:—

1. "The first step in the treatment of ores is their sub-division, which is effected by two novel and ingenious machines, called respectively the breaker and pulverizer. The first of these consists of a horizontal circular table of heavy iron, forty-two inches in diameter, revolving about one thousand times in a minute, having bolted to its upper surface four or more radial bars or blocks of chilled iron, and surrounded by a fixed upright perforated screen. The ore, in fragments not more than six inches in diameter, falling into this aperture, is broken by the revolving bars into dust and small grains, which are ejected through the perforated screen or curb, from which the larger particles are thrown back to complete the breaking. Such a machine with fifteen horse-power will break to the size of sand and coarse gravel eighteen or twenty tons of quartz or hard ore per hour.

"The pulverizer is properly designated as an air-mill, and consists of a horizontal shaft, furnished with arms or paddles, which are made to revolve from one to three thousand times a minute, within an inch of the inner surface of a steel-lined cylinder, varying from eighteen to forty inches in diameter. The previously crushed ore is introduced through an opening in the centre of a plate, which covers one end of the cylinder, and is perforated with numerous small holes.

2. "The calcination of the pulverized ores is effected in what Messrs. Whelpley and Storer call the Water Furnace. This consists of a fire-tower, from twenty to thirty feet high, built of brick, with double walls, and somewhat conical in form, being from three to four feet in diameter at the top, and from four to six at the bottom. Around its upper part are built four fire-boxes, opening into the tower near its summit, which is closed and connected with a large fan-blower. By means of this, besides an abundant supply of air, more or less heated by passing between the two walls of the tower, ore and fuel, in the state of dust, are carried downward into the furnace. The effects obtained by the combustion of charcoal or other fuel pulverized and borne in a current of hot air are very surprising. The finely divided combustible being kindled by the flame drawn from the fire-boxes, burns in the descending current with great energy, and from the comparatively large surface exposed to the action of the air, generates a great amount of heat, and, with an excess of fuel, an intense light. The great fiery blast, nearly filling the tower, can at pleasure be made oxydizing or reducing in its action, by regulating the supplies of fuel and of air. I have seen it at twelve feet from the top, so potent as to heat rapidly to whiteness two feet of a wrought-iron bar an inch in diameter, and cause it, though supported at both ends, to bend like wax beneath

its own weight in thirty seconds after it was placed in the blast. The powerful heating effects which may be obtained by the uses of pulverized fuel are readily understood when we consider that a cubic inch of coal, reduced to particles one five-hundredth of an inch in diameter, will present to the action of the atmospheric oxygen a surface equal to not less than twenty-one square feet.

"The calcination of sulphuretted ores, however, requires but a comparatively low temperature, and an abundant supply of oxygen. The fire-tower of the Water Furnace, being heated to redness, the ore, with or without addition of pulverized fuel, is driven by a small fan into the great current of air down the tower; the sulphur and the base metals are rapidly oxydized and the calcined material falls into the water-tank beneath, while the current of air passes through successive chambers, built over this tank, and open to it beneath. This movement is aided by a large fan-wheel placed at the end of the series, which being furnished with paddles dipping into the water, produces in the final chamber a great amount of spray serving alike to precipitate the suspended dust, and promote the absorption of the sulphurous acid gas. The escape of the excess of this into the air, provided it is not required for further use, is prevented by a second spray-wheel beyond, supplied with milk of lime or some other absorbent.

"In the case of sulphuretted ores of copper, the water-tank is filled with a solution of the chlorids of sodium and calcium, by which, with the aid of the spray-wheel, the sulphurous acid is absorbed, and the oxyd of copper converted into dichlorid. This beautiful process, devised by Messrs. Whelpley and Storer, I have submitted to examination, and have found that the reaction taking place may be represented as involving one equivalent of chlorid of calcium, one of sulphurous acid, and two of cupric oxyd, and giving rise to one equivalent of sulphate of lime, and one of dichlorid of copper,

$$\mathrm{CaCl} + \mathrm{SO_2} + \mathrm{Cu_2\,O_2} = \mathrm{SCa\,O_4\,Cu_2Cl}.$$

"A solution of chlorid of calcium holding oxyd of copper in suspension, rapidly absorbs sulphurous acid gas, and if sufficiently concentrated, is converted into a white crystalline magma of gypsum and dichlorid of copper. This latter salt I find to be soluble in a boiling hot solution of chlorid of calcium, which, however, again deposits it on cooling, a reaction which may probably be found available on a large scale in separating copper from some other metals. In ordinary cases, however, the precipitation of the dichlorid of copper in the furnace-tank is prevented by the presence in the bath of chlorid of sodium, in which, as is well known, the cuprous chlorid is readily soluble.

"The calcined and oxydized ore falling into the tank, which extends sixty feet or more beneath the furnace and its chambers, is carried forward with constant agitation, by means of a submerged rotating helix, and at length falls into a well at the extremity, from which it is withdrawn, freed from oxyd of copper, but generally containing a small residuum of unoxydized sulphid, which, if of sufficient importance, is separated by a repetition of the process with the Water Furnace, or by a rapid calcination in a reverberatory, of the mass impregnated with chlorids, by which means the residual copper left by imperfect burning becomes readily soluble in the sulphurous chlorid bath of the water-tank.

"It will be seen that for sulphuretted ores containing gold, the treatment in the fire-tower, with the aid of a bath of water only, affords a simple mode of desulphurization, and leaves the gold particles in a state most favourable for amalgamation, while in the case of auriferous ores containing copper, a similar result may be obtained and the copper which is lost in the ordinary method of working such ores, recovered by means of the chlorid bath.

"It is claimed by the designers of this series of processes that copper can in this way be produced, at about one-third the cost of the ordinary method. The small consumption of fuel and the mechanical facilities afforded for handling great masses of material, are such that the new method will probably be found especially advantageous, in the treatment of low-grade ores, in regions where transportation is difficult and fuel scarce. The patentees have a small experimental furnace, eighteen feet high, at East Boston, but are now erecting at the Harvey Hill Mine, near Quebec, a furnace thirty feet high, which it is expected will enable them to treat fifty tons of seven per cent. ore in twenty-four hours."

9. PHYSICS.

LIGHT.—In a paper "On the Estimation of Star-colours," Sidney B. Kincaid, Esq., has described a metro-chrome, or apparatus for measuring colour. It consists essentially of three parts:—1, a lantern for the production of a constant light; 2, a contrivance for imparting to that light the necessary colour, and so arranged that the proper tinge once produced, a record of it can be obtained, so as to enable it to be reproduced at any time; 3, an apparatus to throw that coloured light into the field of the telescope as an artificial star, which can thus be viewed side by side with the image of the real one. The source of light is a very fine platinum wire, rendered incandescent by a current of electricity transmitted through it from a Smee's battery of two cells. The platinum wire is brought into the focus of a lens, so that the rays of light from the lantern issue parallel, and therefore come to a focus after passing through the object-glass of the telescope, at the same distance from it as those emitted by a star. The chromographic part of the apparatus consists of a drum rotating about an axis. The drum has in it six equi-distant radial openings—the alternate three of them transmitting the normal light of the lantern, the other three constructed so as to admit flat-sided stoppered bottles containing chemical solutions of different colours. The outer edge of each of the last-mentioned apertures is graduated into ten parts, and each of them can be wholly or partially closed by means of a radial shutter; the other three apertures can be simultaneously closed, wholly or partially, by a triune radial shutter: the edge of one of them is divided into ten parts; and as all are equally affected by the movement of the shutter, the reading applies to the three openings. The drum is made to rotate so as to bring successively the different apertures in front of the lantern; and when the rotation is sufficiently rapid, the impression of colour produced on the retina of the eye will be that of a colour compounded of the colours of the solutions in the three alternate apertures, diluted by the white light transmitted through the other three alternate apertures. By a proper selection of the solutions, and adjustment of the magnitude of the several apertures by means of the shutters, it will be possible to produce the exact colour of a particular star; and then the record of the solutions employed, and of the dimensions of the several apertures, will enable the exact reproduction of such colour at any future period for comparison with the then colour of the star in question. The remaining part of the apparatus is a contrivance for throwing the beam of coloured light into the telescope so as to produce, as already mentioned, the image of an artificial coloured star.

A new and very interesting microscopical object has recently been added to the available novelties for the cabinet. Mr. J. B. Dancer has made the curious discovery, that when the ash or dust which collects in the flue of a furnace is examined under the microscope with a power of 40 or 50 diameters, it is found to consist of ferruginous matter and crystallized substances, some particles transparent, others white and red. It contains also a number of curious-looking objects, which vary considerably in size and colour; the majority of these bodies are spherical, and when separated from the irregularly shaped particles forming the bulk of the dust, they become interesting objects for the microscope. Some are as perfect in form as the most carefully turned billiard balls, and have brilliant polish. Some are transparent crystal spheres; others are opaque white; many are yellow and brown, and variegated like polished agates or cornelian of different shades. There are others which look like rusty cannon balls; some of these have an aperture in them like a bombshell, and many are perforated in all directions.

To obtain these objects, the dust should be washed in a bowl, and all the lightest particles allowed to float away; the remainder consists of fragmentary, crystalline, and ferruginous substances; mixed with these are the polished balls described, which, under the microscope by a brilliant reflected light, look like little gems. To separate the spherical bodies from the irregular ones, it is only necessary to sprinkle some of this material on an inclined glass plate, and by gentle vibration the balls roll down, and can thus be collected. Mr. Dancer considers the transparent spheres to be silicates of soda or potash; the opaque white are most likely silicate of soda or potash, combined with lime and alumina; the yellow and brown are silicates coloured by iron in different proportions. The black globes are not all alike in composition; some of them are silicates coloured by carbon, others are iron balls coated externally with a silicate. Many of these rusty cannon balls are probably ferrous oxide, formed by the action of heat on the iron pyrites in the coal. There are also balls of black magnetic oxide; the perforated shells are probably ferrous sulphides. The globular form of these bodies suggests that they have been thrown off in scintillations, such as are seen during the combustion of iron in oxygen gas, and whilst in a fluid state they assume a spheroidal form. They are carried by the draught into the flue, and being of greater specific gravity than the carbonaceous matter forming the smoke, they fall before the current of air has reached the chimney. Some of the dust has been a considerable time in the flue, exposed to the intensely heated circulating flame; the reducing action of this would probably convert some of the oxide into metallic iron. Many of these balls have the appearance of reduced oxides. The movements of these objects, caused by the approach of a magnet under the stage of the microscope, are somewhat amusing, and it is at times startling to see the crystalline objects, both spherical and irregular, exhibit magnetic attraction.

That indefatigable experimentalist, M. Schönbein, has just made a further discovery respecting ozone. He finds that ordinary oxygen is without action upon the protoxide of thallium, while ozonized oxygen combines rapidly with this oxide, so as to form the peroxide of thallium, which is brown. Paper steeped in a solution of oxide of thallium and exposed to free air, would be an excellent ozonometric paper, if the carbonic acid of the air did not transform the oxide into carbonate, which passes more slowly to the state of peroxide, and blackens with difficulty under circumstances where strips of paper, iodized and starched, become coloured at the end of a few minutes in an atmosphere which contains a 1-2,000,000th part of ozone. The comparison between the two papers has at least the advantage of proving that the coloration of the iodized paper is really produced by the atmospheric ozone, and not altogether by nitrogen compounds, as believed by many.

An apparatus for measuring the different degrees of transparency of the air has been lately described by M. de la Rive, of Geneva. According to M. de la Rive, the great transparency of the air before rain is due to the presence in the air of a quantity of invisible vapour, which renders transparent the numerous germs floating in the air, to whose presence light mists are attributed.

HEAT.—Gas has long been a common adjunct to English chemical laboratories, and thanks to Mr. Griffin, the scientific man here is provided with a multiplicity of gas furnaces, for obtaining all kinds of results, from the slow evaporation of a pint of water to the fusion of ten pounds of iron. In Paris, however, gas furnaces are only just coming into vogue, and in their usual happy way our continental confrères are rediscovering many forms of apparatus which are well known here. At a recent meeting of the Academy, M. Debray described two forms of apparatus for producing very elevated temperatures by means of common gas mixed with air. The first was said to be a form of M. Schlösing, modified by M. Wisnegg; the second, that of M. Perrot. If a certain number of Bunsen burners be united together so as to form one single jet of flame, without, however, complete incorporation, the heating power is most remarkable, provided a sufficiently energetic and swift draught is given to it. The form of the furnace must also be varied, and the draught regulated according to circumstances. With an apparatus burning 70 cubic feet per hour, under a pressure of two or three inches of water, and without any draught but that obtained by a sheet-iron pipe 6½ feet high, M. Debray was able, in fifteen minutes, to melt 1·48 lb. of silver. It only takes half-an-hour at most, when the operation is at full work, to melt and cast upwards of 2 lbs. of copper into a bar. Lastly, M. Debray melted several specimens of grey and white iron. A pound of a variety of cast-iron, which was considered very difficult to melt, was run in thirty minutes; another piece, weighing 1½ lb., was melted in an hour or so. During the operation, the crucible can be examined in the interior by the aid of a mirror or a bucket of water, which can receive the metal in case of accident. There appear to be more points of novelty in this furnace than in most of the French adaptations, but it is very similar to Gore's Gas Furnace in its effects, and not unlike it in principle.

The evaporation of large masses of liquids, simple as it may appear on the small scale, is a formidable operation when many tons weight of liquid have to be dealt with. M. E. Parion, at Wardrecques, St. Omer, has invented a new process for the renewal of the surface of the liquid exposed in the state of fine division in contact with the air, or to the products of the combustion, according as the evaporation should take place with or without the aid of artificial heat. When the evaporation takes place by the aid of the temperature of the air alone, the liquids are divided into a small shower exposed to the wind and sun. By maintaining them in this state we obtain in a small space, and one easy to cover when necessary, the same results as the concentrating basins and the graduating buildings give at great cost and with a vast extent of land. In the case of the employment of artificial heat, the waste heat from chimneys of factories is utilized in preference, and in the absence of this any source of heat is employed if the products obtained have a sufficient value to pay the expenses.

The artificial production of ice is a problem which has attracted considerable attention of late years, and amongst the inventors of practically useful pieces of apparatus, M. Carré is one of the most successful. He has now described some new machinery for the production of cold, based upon the rapid evaporation of water aided by an air-pump and sulphuric acid. The apparatus would be difficult to describe without the aid of diagrams, but we may state that his air-pump is very cheap, and has worked without repair for eighteen months; the receivers for acid are formed of an alloy of lead and antimony, which will resist for a number of years the attack of sulphuric acid. The pump is made of copper, and the sides are constantly coated with oil. The valves are moved mechanically. The apparatus retains a vacuum for many months, and one kilogramme of acid at 66° produces two or three kilogrammes of ice. Freezing commences three or four minutes after exhausting.

ELECTRICITY.—The theory of Grove's gas battery has occasioned perhaps more discussion than that of any other instrument of the electromotor class. When it was first described by the learned inventor, M. Schönbein made certain objections to Mr. Grove's explanation of its action; but these did not attract the attention they deserved at the time. M. J. M. Gaugain has now arrived at the same conclusion as Schönbein, using a different mode of investigation. He only worked with one element at a time, and instead of measuring the intensity of the current, he measured the electro-motive force directly by the method of opposition. In this manner the influence of the modifications which were successively introduced into the arrangement of the couple could be numerically estimated. The author explains how it is that Mr. Grove arrived at a different result to his own. Mr. Grove considered it indispensable that each of the platinum electrodes should be simultaneously in contact with one of the gases and the liquid beneath. M. Gaugain finds, however, that when the platinum wires are immersed completely in the liquid, and therefore out of contact with the gas, the electro-motive force is exactly the same as when arranged according to Mr. Grove's principle. It follows therefore that the action of the platinum only extends to the dissolved gas, and that the vessels containing oxygen and hydrogen serve no other purpose than that of keeping the water over which they stand fully saturated with gas. The author has found that the electro-motive force of the gas battery is not modified by replacing the oxygen vessel by one containing carbonic acid, and the general conclusion at which he arrives is that the electro-motive force put into play in Grove's battery is due exclusively, or almost so, to the affinity exerted between the oxygen of the water and the hydrogen condensed by the platinum electrode.

A new force will have to be introduced into chemical physics—that of capillarity. We notice it under the present heading, inasmuch as the effects appear to be more nearly allied to those of electricity than to any other force. M. Becquerel, sen., has been experimenting for some time on what he now terms capillary chemistry. He finds that chemical decompositions take place under the influence of capillarity, and he thinks he has proved that these curious phenomena are produced under the triple influence of affinity, capillarity, and electricity. To demonstrate the intervention of electricity, M. Becquerel has made the following experiment: he immerses a *split* bell-glass, containing nitrate of copper, in a second glass, containing a solution of monosulphide of potassium; then he dips the two extremities of a silver wire, one into the nitrate and the other into the monosulphide. A constant electric current is formed, and the deposit of silver is made, not in the capillary slit, but on the iron. When the wire is removed, the deposit is formed in the slit, and on the edges along the sides of the split bell-glass. The capillary action is as powerful as an electrical action. M. Becquerel has since improved his experiments; for the split bell-glass he substitutes prisms of crystal pierced with a small hole; the slit or fissure is replaced by plates of glass with edges in contact, or even by sand, and he has thus obtained effects of silvering, gilding, platinizing, and very remarkable deposits of gold, silver, nickel, and cobalt. At one of the meetings of the French Academy he exhibited several specimens of metals reduced and precipitated by capillary action. In order to answer the objection that these phenomena of reduction or precipitation might be attributed to the action of the alkalies of the split glass tube, he has employed polished plates of rock-crystal pressed one against the other, so as to leave only a very small interval; he has thus obtained perfect reduction of several metals. The interval between the plates must be varied according to the different metals. For the reduction of gold, for example, the space between the plates must be less than that for copper.

In an investigation on the inductive current of the Ruhmkorff coil, M. Blaserna, Professor of the University of Palermo, has arrived at the following conclusions respecting the passage of induction currents:—1. The time elapsed between the closing or the rupture of the circuit and the apparition of the current of induction, or the attraction of the armature for the bobbin of induction, is inappreciable, being less than the fiftieth part of a second. 2. The current of induction, feeble at its commencement, increases little by little, then diminishes, and is extinguished in an interval difficult to determine.

All who have experimented much at electrotyping have been troubled by a defect in the electro deposition of copper, which is sometimes seriously injurious, *viz.* its brittleness. M. Bouillet has found that a very small quantity of gelatin dissolved in the bath gives a copper of nearly equal malleability to rolled copper, whereas the pure bath only gives a porous, defective metal-like cast copper. The relative specific gravities of copper in different states are: cast copper, 8·78; laminated copper, 8·95; galvanic copper, 8·86.

Gutta-percha moulds are exclusively used by the large firm of Christophle and Co., Paris. They are applied either cold by pressure with a lever, or by the hand. The mould is rendered conductive either by blacklead, or silver, reduced from the nitrate by nascent hydrogen.

10. ZOOLOGY, ANIMAL PHYSIOLOGY, AND MORPHOLOGY.

Morphology.

Occluding Apparatus of the Tracheæ in Insects.—Burmeister was the first who showed that insects have a means of closing up their tracheæ so as to prevent all communication with the exterior. The subject has since been studied by Herman and Leonard Landois, and by W. Thelen. They have found an apparatus adapted for this purpose in all insects, consisting of an imperfect chitinous ring (a muscle) ligament, and sometimes an accessory lever. Such an apparatus is placed in each main tracheal stem below, and independent of the stigma. Dr. H. Landois and W. Thelen have recently published a joint memoir on the subject. The complexity of development of this apparatus they show varies very much in different orders of insects, and in the Neuroptera is reduced to a minimum. In many cases it is so much developed, as to constitute a sort of larynx, and as such may serve as a vocal organ. The solid chitinous parts are always connected in such a way, that in a state of quiescence the tracheal tube remains open, and gives free entrance and exit to the air through the stigma. Muscular action is necessary to close the apparatus. This is effected in all cases by a single muscle, which differs in different species in the greater or less number of its fibrillæ. Dr. Landois and his colleague point out that a closing apparatus of some kind, to the tracheæ, must be required in all insects, inasmuch as the movement of the air in the tracheæ can only be effected by the movements of the body or muscles, &c., which, were the exit of the air at all times free, would have as great a tendency to expel it through the stigmata, or even a greater, than to force it onwards into the minute ramifications of the tracheal system. The memoir, which appears in Kölliker's 'Zeitschrift,' is most beautifutly illustrated, and contains descriptions of the "occluding apparatus" of more than twenty insects of various orders.

Relative Size of Terebratulæ.—The largest living species of Terebratula has been lately noticed by Mr. Davidson, who devotes himself to the study of the Lamp-shells. Rear-Admiral Sulivan dredged the specimen in question in the outer harbour of Port William, in the Falkland Islands, and has submitted it to Mr. Davidson, who considers it identical with the *Waldheinia venosa* of Solander. It is a remarkable thing that the largest Terebratulæ known occur in the crag strata, exceeding this species in length by an inch (*W. venosa* has been found 3 inches 2 lines in length, and *T. grandis* 4 inches 2 lines). Very large species occur in Cretaceous beds, and still larger in Jurassic strata, but not so large as the Tertiary or the Recent species. In the Triassic and Palæozoic periods only few and diminutive species occur. It is worth noticing that the very large species of all periods, whether belonging to the short or to the long-looped sub-genus, have a very marked similarity in the outline and form of their shells.

A new Annelid from Dieppe.—Dr. Richard Greeff has found a new species of the annelid-genus *Sphærodorum* in the oyster-beds at Dieppe. *Sphærodorum* is the name given by Œrsted to one of the strangest of Chœtopodous worms. The little creature does not exhibit very well-developed feet-appendages, or a high form of cephalization; but it is remarkable for the large globular capsules, containing coiled-up, worm-like bodies, which are disposed in series on the rings of its body. Professor Kölliker has shown that it is most probable that these capsular bodies are large glands. The species known to Œrsted had only two of these warty processes on each body-ring, but that described by Dr. Greeff has ten. It differs, moreover, very greatly in size from the first known species, which is described as having a "serpentiform" body two inches in length, while Dr. Greeff's species is a stumpy little creature only two millimetres long. It is most probable that the new species is a very immature form.

The European Hyalonema.—The Glass-Rope controversy is not yet ended, for while Professor Ehrenberg has given up his belief that *Hyalonema* is an artificial Japanese product, and Professor Max Schultz seems to gain most support in regarding them as the joint productions of a sponge and a polyp, Professor J. V. Barboza du Bocage is doing his best to prove that a European *Hyalonema* is found off the coast of Portugal. In two letters to Dr. Gray, of the British Museum, he has given the names of persons (mostly fishermen) who have obtained altogether twelve specimens of *Hyalonema* for him, when engaged in the shark-fishery. He considers there can have been no fraud, as vessels do not sail from the part of the Portuguese coast in question to Japan. Moreover, he says that the fishing people and others know them as "chicote de mar," that is to say, "sea-whips." Altogether, the evidence seems to be in favour of the reality of *Hyalonema Lusitanicum*, but its occurrence must be still regarded as a very strange and anomalous fact. Perhaps, before long, the distribution of *Hyalonema* may be shown to be very much wider than was supposed, and then the strangeness of a genus having representatives only in Japan and Portugal will disappear.

PHYSIOLOGY.

Regeneration of Limbs.—M. Philipeaux has been of late favouring the French Academy with various communications on the regeneration of limbs or organs of various animals, after amputation or excision. He has made a large series of experiments on the re-development of the spleen, and has found in all cases that it is not regenerated unless a certain portion has been left as a starting point for the new growth. So, too, with the fore-limbs of the larger Newt; when amputated so as to leave the basal portion intact, the limb was rapidly and entirely re-formed, but when the limb was removed with the scapula, nothing was produced but a cicatrix. M. Philipeaux has now made similar experiments on some of the Mexican Axolotls, which were hatched in the Jardin des Plantes last year. The experiments were made on ten individuals, five of which had the left anterior limb entirely amputated, and five the right anterior limb only partially so—that is to say, leaving the head of the humerus and the scapula. In all five of the first series there is now a simple cicatrix; in all five of the second series, the whole limb has been completely regenerated.

Muscular Contractibility.—M. Rouget has been studying muscular contraction, and has taken as his starting point the stem of the *Vorticella*. He repeats the well-known observations on that structure, and remarks that the state of repose in the *Vorticella*-stem in its contracted condition is shown principally by its assuming this state when freed in any way from the bell-like body it supports.* M. Rouget then asks, "Is this peculiar to the *Vorticella*-stem, or is it the condition of muscular contraction in all animals?" The matter is worth consideration certainly, and has been considered by many physiologists, who do not, however, all assume the identity of Vorticella-stems and muscular fibres. M. Rouget intends shortly to prove—1st, that a recent hypothesis, according to which permanent contraction is essentially constituted by a series of successive shocks or vibrations, is in absolute contradiction to well-observed facts; 2nd, that a tendency towards extreme contraction is a property inherent in living muscular fibre, a necessary consequence of its structure and elasticity; 3rd, that during life this tendency to contraction is combated by a cause of extension which predominates during the repose of the muscle, is developed in the exchange of the nutritive materials, increases with the activity of their access, diminishes or becomes extinguished by their exhaustion, and may be momentarily suspended by all the excitants of muscular contractility—nervous action, heat, the electric shock, &c.

Do the Hare and Rabbit breed together?—Dr. Pigeaux has been making some inquiries into this matter, and believes that never, or quite accidentally and rarely, does the hare breed with the rabbit. The so-called "Léporides" are true rabbits, and not hybrids at all. The belief in the existence of such a hybrid was prevalent among the ancients, and indeed is so among some moderns, but is merely due to the existence of varieties of the rabbit having somewhat the aspect of hares. By keeping hares and rabbits in confinement, and carefully managing them, hybrids may be obtained, and a case is quoted by Dr. Pigeaux. It does not appear, however, that the mule was fertile, and it was, moreover, an unsatisfactory creature in other ways, having from a culinary point of view neither the advantages of the hare's flavour nor the rabbit's whiteness.

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* A better proof than the one given by M. Rouget is that *Vorticella* (in common with many similar forms, and with the contractile parts of others) extends *slowly* and contracts *rapidly*. We know well that if we wish to extend a spiral spring, it is a slow process compared with its contraction.—The Editors.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT DUNDEE, SEPTEMBER, 1867.

THE meeting which has just closed has rivalled in interest and number of visitors any of the previous northern gatherings, with the exception of the Aberdeen meeting, which was perhaps exceptionally large, owing to the Presidency of the late Prince Consort. Last year it was our duty to draw attention to the very high charges for lodgings made by the inhabitants of Nottingham: we are glad to say that no complaints of this character can fairly be made against Dundee. The attendance in the Sections has been better than usual, and the earnestness of those who went for strictly scientific purposes was shown by the number of papers announced in each morning's journal, and by the length and interest of the discussions which the more important of these papers elicited.

The value of these autumnal meetings of the Parliament of Science becomes every year more and more apparent. The chief advantage, however, does not arise from a diligent attendance at the Sections, but from those impalpable influences which result from a lounge in the reception room—a picnic or excursion to some place of note in the neighbourhood—a look-in at the B.'s, the Red Lions, or the Eastern Club. Men, who before only knew each other in the pages of a scientific journal, here meet in friendly companionship, and the keen scientific antagonist becomes a personal friend for life. A controversy which has been dragging on for years is settled by ten minutes' personal explanation; and opponents who were rapidly approaching the orthodox scientific intensity of hatred, carry away from such a meeting mutual forbearance and respect. These are precious results, and if the Sections are of no other use, they have the inestimable advantage of drawing men of kindred pursuits together from all parts of the kingdom, and giving them an excuse for a week's holiday under the convenient pretext of attending a scientific meeting.

At the General Meeting which took place on Wednesday, the 4th of September, the usual reports were read. One of these, the report of the committee appointed by the Council of the Association to consider the best means for promoting scientific education in schools, deserves more than a passing notice. The report, after pointing out that there is already a general recognition of science as an element in liberal education, and stating that general education in schools ought to include some training in science, went on to refer to the difficulties in the way of introducing science into schools,—difficulties which the committee, however, considered easily surmountable. With a view to the furtherance of the scheme, the committee made the following suggestions :—

1. That in all schools natural science be one of the subjects to be taught, and that in every public school at least one natural science master be appointed for that purpose.

2. That at least three hours a week be devoted to such scientific instruction.

3. That natural science should be placed on an equal footing with mathematics and modern languages in effecting promotions, and in winning honours and prizes.

4. That some knowledge of arithmetic should be required for admission into all public schools.

5. That the universities and colleges be invited to assist in the introduction of scientific education by making natural science a subject of examination, either at matriculation, or at an early period of a university career.

6. That the importance of appointing lecturers in science, and offering entrance scholarships, exhibitions, and fellowships for the encouragement of scientific attainments, be represented to the authorities of the colleges.

Usually the great feature of the meeting has been the President's address. This opportunity is generally taken for giving a comprehensive review of the progress of the various branches of science during the past year, and not unfrequently speculations are indulged in, or old truths are put forward in so novel a light as to cause the address itself to be not the least valuable scientific memoir which the year has produced. Such was the magnificent inaugural speech delivered by Mr. Grove, the late President, whose key-word—continuity, introduced a subject of dissertation worthy of the author of the "Correlation of Forces." This year the members of the Association have no such fruitful harvest of speculation to look back upon. The address was short, and was delivered by his Grace the Duke of Buccleuch, without notes. Its delivery had no pretension to eloquence, and for the most part it consisted of apologies for the speaker's shortcomings. To quote one of the local papers—

"The address was an utter, hopeless, complete failure, producing a blank sense of dismal disappointment, deepening into one of painful pity for a man who had suffered himself to be placed in such a false position; and after a few minutes, though it was a Duke that was speaking, it was impossible for those who wished to help his Grace to prompt anything which could be construed into general applause." . . . . "The props of pride of place and confidence in self broke down one after the other, and the unfortunate speaker went on stumbling unsupported through confused commonplace and feeble platitude."

PHYSICAL SCIENCE. (Section A.)

The proceedings in this Section were opened by an introductory address, delivered by the President of the Section, Sir Wm. Thomson, F.R.S. It was very short, and was delivered mainly to give the speaker an opportunity of adding his tribute to the memory of the great man whose loss all cultivators of physical science deplore. He said he should not attempt to give any account of Faraday's discoveries and philosophy—*those* live for us still. He wished he could put in words something of the image which the name of Faraday always suggested to his mind. Kindliness and unselfishness of disposition; clearness and singleness of purpose; brevity, simplicity and directness; sympathy with his audience or his friend; perfect natural tact and good taste; thorough cultivation—all these he had, each to a rare degree; and their influence pervaded his language and manner, whether in conversation or lecture. But all these combined made only a part of Faraday's charm. He had an indescribable quality of quickness and life. Something of the light of his genius irradiated all with a certain bright intelligence, and gave a singular charm to his manner, which was felt by every one, from the deepest philosopher to the simplest child who ever had the privilege of seeing him in his home—the Royal Institution. That light is now gone from us. While thankful for having seen and felt it, we cannot but mourn our loss, and feel that, whatever good things may yet be in store for us, *that* light we can never see again.

It will be impossible to notice any but the more important of the papers read before the Sections, in the limited space which can be devoted to this subject. The report of the Lunar Committee was first brought forward by Mr. Glaisher and Mr. Birt. The objects originally contemplated in the appointment of the Lunar Committee were:—

1. The registration of craters and visible objects on the moon's surface in forms prepared by the Committee.
2. The construction of an outline map of four times the area of Beer and Mädler's, according to the plan proposed by Mr. Birt.
3. The conducting correspondence on the subjects.

The report gave a detailed account of the manner in which these objects had been carried out. Some attention was devoted to the alteration which is supposed to have taken place in the crater Linné. Mr. Birt said that there was an opinion that this crater had been filled up by a volcanic eruption.

Prof. J. Clerk Maxwell read a paper on a real image stereoscope. In this instrument a frame containing a large single lens is placed in front of the pictures, and the observer stands about two feet from the instrument; he then sees, just in front of the lens, a real and inverted image of each of the two pictures, the union of which forms the appearance of a solid figure in the air between himself and the apparatus.

Dr. Balfour Stewart, Superintendent of Kew Observatory, read a paper "On the Behaviour of the Aneroid Barometer at different Pressures." Experiments had lately been made with the view of ascertaining to what extent an Aneroid may be considered a reliable instrument when exposed to considerable changes of pressure, such as occur in mountain districts. By means of an air-pump, the Aneroids, when placed in a receiver, might be subjected to any pressure. A method of tapping the Aneroids had also been devised, and by this means the experiments as to the deviation of the results given by these instruments were conducted with comparative ease, and with the greatest accuracy.

The next day Mr. Glaisher gave a report on luminous meteors, which was followed by an interesting discussion in which Professor A. Herschel said that the connection between comets and meteors had this year been established without doubt. He would not say that every shooting star was a comet. They were more likely the dissipated parts of comets—probably comets torn into shreds by the sun's attraction drawing them into space.

Some papers by Sir David Brewster on various optical subjects followed: one of these gave an account of experiments which, Sir David remarked, were sufficient to establish the almost incredible truth, that the colours of the soap bubble are not produced by different thicknesses of the film itself, but by the secretion from it of a new substance flowing over the film, expanding under the influence of gravity and molecular forces into coloured groups of various shapes, and returning spontaneously, when not returned forcibly, into the parent film.

The President, Sir William Thomson, next read an important paper on a new electrical machine founded on induction and convection. The principle of the machine was that of the "Successful Merchant," who commenced his life with the capital of ½*d*., and after a month's persevering industry, realized the handsome sum of £1, and continued to go on increasing his capital at a compound rate of interest. The object of the instrument referred to was not indeed to increase money, but electricity, and that increase was at a compound rate. Precisely in conformity to the law which applied to compound interest and the increase of the successful merchant's capital was the increase of 'electricity by this machine. Given the smallest quantity of electricity, and the instrument increased it at the rate of compound interest, and this increase went on at a perfectly uniform rate. But just as the capitalist finds that he cannot always go on getting higher and higher interest for his money, but must ultimately, perhaps, be content with 4½ per cent. instead of 5, so was it to some extent with this machine. When a very high charge was reached, the increase of the quantity of available electricity was not so great, owing to sparks passing in various parts of the machine, preventing the operator from retaining the full quantity of electricity which was got by it. There was great necessity for an easy-going electric machine, and that now shown fulfilled this condition.

Two papers by Mr. Ladd were next read on some new magneto-electric machines; and Mr. Claudet brought forward his discoveries in binocular vision, and his self-acting focus-regulator.

The greater part of the proceedings in this Section on Monday consisted of a paper and discussion on the storm-warnings—their importance and practicability; and a resolution was carried unanimously that this Section apply to the Council of the British Association to make a communication to Her Majesty's Board of Trade, urging them to institute arrangements for carrying storm-signals to be resumed. Colonel Sykes brought forward ample evidence to show that these warnings should be resumed. Mr. John Don, the President of the Dundee Chamber of Commerce, also spoke in favour of their resumption. Mr. D. Milne Holme, of Wedderburn, Dr. Balfour Stuart, the Duke of Buccleuch, Sir John Ogilvy, and others, took part in the discussion.

The proceedings opened on Tuesday with some meteorological papers, which were followed by several papers on electrical subjects. The chief subject of interest was the alleged correspondence between Newton and Pascal. Two papers were read bearing on the question; one by Professor Hirst, stating some of the circumstances attending the production of the correspondence before the Academy of France, and indicating grounds for receiving with caution this remarkable claim that has been put forward by the Academy—a claim which if established would transfer to Pascal much of the glory that has been associated with the name of Newton. Sir David Brewster also read a short paper, pointing out that the correspondence was a forgery, almost unparalleled in literary or scientific history. M. N. de Khanikof, a celebrated French Orientalist, made an interesting speech on the MSS. of Pascal, and spoke highly of M. Chasles, who had brought the correspondence referred to before the notice of the scientific public.

Section A was the only one which sat on Wednesday, when three papers were read. The first was a very important one, by Professor Wheatstone, "On a New Telegraphic Thermometer." The apparatus consists of two distinct instruments, connected only by telegraphic wires. The first is called the questioner, the second the responder. With this apparatus the indications are not spontaneously conveyed to the observer, but they must be asked for, and whenever this is done the indications will be immediately transmitted to him, however frequently the question is put. The uses to which this Telegraphic Thermometer may be applied, are, among others, the following:—the responder may be placed at the top of a high mountain and left there for any length of time, while its indications may be read at any station below. Thus, if there should be no insuperable difficulties in placing the wires, the indications of a thermometer placed at the summit of Mont Blanc may be read as often as required at Chamouni. A year's hourly observations under such circumstances would no doubt be of great value. If it be required to ascertain during a long-continued period the temperature of the earth at different depths below its surface, several responders may be permanently buried at the required depths. It will not be requisite to have separate questioners for each, as the same may be applied successively to all the different wires. The responder, made perfectly water-tight, in which there would be no difficulty, might be lowered to the bottom of the sea, and its indications read at any intervals during its descent. In the present mode of making marine thermometric observations, it is necessary that the thermometer should be raised whenever a fresh observation is required to be made.

The next paper was one by Major Tennant, regarding the steps that are being taken by the Indian Government to ensure extensive and correct observations of the total solar eclipse of 1868. This will be seen to great advantage in India, and the totality will last almost the maximum possible time—about five-and-a-half minutes. Arrangements will be made to obtain as many photographs as possible of the phenomena of totality, and spectrum-observations will also be made of the corona.

CHEMICAL SCIENCE. (Section B.)

The President of this Section, Professor Thomas Anderson, opened the proceedings on Thursday, the 5th of September, by an address, in which he passed in review the new theories which have lately been introduced into Chemistry, which have had the effect of unsettling the views formerly entertained without as yet introducing anything conclusive in their place. Dalton's atomic theory has proved itself no longer sufficient; it has done its work, and in the future is less likely to act as an assistance than as a hindrance to progress. Sir B. Brodie's theory is one from which the idea of atoms is excluded, although it is by no means incompatible with them. It is a system which involves a very great amount of hypothesis, for the assumption of the compound nature of certain of the elements is rendered necessary by Sir Benjamin's fundamental hypothesis. The question must at best be considered as still *sub judice*, and the method is not likely to meet with general acceptance until it is supported by a much larger body of facts than those we at present possess.

The most important paper read this day was one "On the Decay of Stone, its Cause and Prevention," by J. Spiller. The author has arrived at the conclusion that the corrosive action of sulphurous and sulphuric acids in the atmosphere, resulting from the combustion of coal-fuel, operates, in large towns especially, in a very destructive manner upon dolomite and the numerous class of limestones commonly employed in our public buildings; this chemical action, aided no doubt by the simultaneous attack of carbonic acid and moisture, and in the winter season further supplemented by the disintegrating effects of frost, furnishes a sufficient explanation of all the facts observed. The best coal and coke contain one per cent. of sulphur, equal to 70 lbs. of oil of vitriol for every ton of coal burnt. This is the origin of the sulphates invariably present in the loosened crust of decayed stones, whether of calcareous or magnesian character. As a remedy for the decay of stone, Mr. Spiller proposes the application to the cleaned surfaces of the stone of an aqueous solution of superphosphate of lime,—a salt remarkable for its action in hardening the surfaces of chalk, Caen stone, or other calcareous building stone to which it may be applied, either by brushing or immersion, and which acts upon the carbonate of lime in the stone, giving rise to the formation of crystallized diphosphate of lime.

The author brought forward some interesting results to record in connection with the treatment of Portland stone, which serve to illustrate the increased hardness and strength, and the diminished rate and capacity of water-absorption, attending the employment of the superphosphate. The cost of materials employed in the treatment of stone according to this plan is very trifling, and bears but a small proportion to the cost of labour necessarily expended upon the cleaning and preliminary preparation of the stone before the solution can be applied. One gallon of solution will cover about 300 feet superficial, when two coatings are applied upon Caen or Portland stone. The superphosphate employed must not contain any appreciable amount of sulphuric acid, and the specific gravity of the solution, when diluted for use, should be about 1,100.

Mr. Walter Weldon read a paper "On the Regeneration of Oxide of Manganese in Chlorine Stills."

The author stated that the essential features of the process consisted, firstly, in the use of an *artificial* oxide of manganese, capable of liberating from a given quantity of hydrochloric acid about twice as much chlorine as could practically be obtained therefrom by means of a 70 per cent. native oxide; and, secondly, in a simple method of reproducing the artificial oxide from the "still-liquor." This recovery of the artificial oxide might be performed in the stills themselves, so that a charge of manganese, once placed in a still, might always remain therein, continually generating chlorine; and not only never requiring removal, but never undergoing diminution of properties, nor suffering loss by waste.

On Friday the following papers were read, "On the Present Use of Lichens as Dye Stuffs," by Lauder Lindsay; "On the Determination of Nitrogenous Organic Matters in Water," by Dougald Campbell. The latter paper proved that the method of estimating the amount of nitrogenous matter in water proposed by Messrs. Wanklyn, Chapman, and Smith, was erroneous. "A description of a new Ether Anemometer," by Alfred E. Fletcher, Government Inspector of Alkali Works for the western districts. The construction of this apparatus is based on the fact that a current of air passing across the open end of a straight tube causes a partial vacuum in it. An application of this principle is seen in a small toy in common use, in which a liquid is made to ascend several inches in a vertical tube, by blowing through another tube across its open end. It rises by virtue of the partial vacuum caused by the current of air which crosses it. By the aid of this Anemometer the speed of any current of air in flues or chimneys can be measured by simply boring a hole one inch diameter through the brickwork, and inserting two tubes, one with a bent, the other with a plain straight end as already described, and making the necessary observation of the floats; and in this operation neither soot, heat, nor corrosive vapours can prove any hindrance. So sensitive is the apparatus that on a windy day the effect of each successive gust of wind is observable, as it causes variations in the draught of the chimney. The instrument may be used as a wind gauge by fixing through the roof of an observatory a small vertical pipe, presenting a plain open end to the wind. The lower end of this pipe brought down into the observatory and connected with the ether manometer would communicate the varying pressures due to the varying speed of the wind.

On "An Apparatus for indicating the Presence and Amount of Fire Damp in Mines," by George F. Ansell. The idea embodied in the apparatus was founded on the law of diffusion announced by

Mr. Graham, that gases diffuse in the inverse proportion to the square root of their densities, or, more popularly, that light gases diffuse more rapidly than heavy ones. Mr. Ansell showed, by experiment, that when a tube closed at one end by plaster of Paris, was filled with common coal gas, the lighter part of the compound was rapidly diffused through the plaster, as was at once seen by the yellow flame and slight explosion which ensued on bringing a lighted match close to the closed end. Hence, Mr. Ansell said, his proposition. In a pit the case is the reverse of that of the tube. There the gas is ready to escape into the galleries, and the apparatus must therefore be modified to suit the varying circumstances. The essential parts of the apparatus may be described as consisting of an alarm bell and a telegraph needle—the former being rung and the latter deflected by an electric current, which was set in motion by the action of the dangerous gas. The means by which this was effected consisted of an iron cup, on which was fixed a disc of white Sicilian marble, standing on a U-tube, which contained a quantity of mercury. The marble here represented the plaster which closed the end of the tube in the first experiment, and through it the dangerous gas was diffused. As it did so, the mercury was pressed up into the other extremity of the tube, completed the previously broken circuit, and an alarm was given by the ringing of the bell and the deflection of the needle.

"Notes of Analyses of Gold Coins of Columbia, New Grenada, Chili, and Bolivia, with some Account of the Operations of Gold Mining in Nova Scotia," by George Lawson, Ph. D. The first part of this paper was principally devoted to the history and description of the gold coinage of the above-mentioned countries, with physical and chemical analyses. Some information was then given respecting the composition of the native gold of coining countries, and a useful list was appended, showing the principal gold coins of various countries, with their weights, fineness, and values, and a synopsis of the results of assays and analyses of native gold from the chief mines of the world. The author then proceeded to make some remarks on the process lately invented by Mr. Crookes, by which sodium amalgam is added to the mercury. He stated that he had experimented to a considerable extent on the effects of sodium amalgam, and found it to exert a very remarkable power in facilitating the absorption of gold by mercury, quite independently of any action of the soda necessarily formed during the operation. The coating of the copper surfaces with mercury alone had been found practically to be a troublesome and tedious operation; but the use of a little sodium amalgam added to the mercury enabled the coating to be given by a simple rubbing without any waste of time. Some illustrations of the advantages of Mr. Crookes's process were then given. It was stated that in some experiments undertaken in conjunction with Dr. Krackowizer, formerly of Vienna, at the Lake Major Mines, a quantity of pyrites collected from the tailings (after passing through the mill in the usual way) was re-subjected to the action of mercury, to which sodium had now been added, and by this means the waste material from which all the gold was supposed to have been abstracted, yielded a fresh supply at the rate of five ounces of gold per ton of pyrites.

In the discussion which followed the reading of this paper, Mr. Crookes said that there was one thing which ought especially to be attended to in employing this process, and that was to avoid introducing too much sodium. Every failure which had come under his notice had arisen from ignorance of the action which the sodium was intended to exert on the mercury. If too much were added it exerted a chemical action, reduced the iron, copper, lead, &c., which might be present in the ore, and loaded the mercury with base metals, destroying its power of wetting gold, and causing it rapidly to flour away when triturated in a stream of water. If, however, only a trace of sodium were introduced (say 1 in 10,000 or 1 in 100,000), it acted physically rather than chemically; it put the mercury into a highly electro-positive state, and by greatly widening the electric interval between this metal and gold, increased their mutual affinity.

A paper was afterwards read "On certain new Processes in Photography," by J. Spiller. He first described what is known as the Woodbury-type process, which is based on the insolubility of chromo-gelatin after exposure to light, and upon the subsequent action of water upon a sensitive film, which has been in different degrees influenced by insolation under an ordinary photographic negative. The depths of tint in the original are represented by variations in the thickness of the film of gelatin left unacted upon by water, and this dried may then be used as a matrix to produce a corresponding series of depressions upon a surface of lead or type-metal by the aid of a powerful hydraulic press. The blocks so produced serve for printing off a great number of proofs when they are liberally "inked" with warm gelatin, highly charged with Frankfort black or other suitable pigment, and pressed down upon a smooth sheet of paper until the excess of ink is forced out on all four sides of the block, and so removed from the space constituting the picture, which, when set, is, lastly, protected with a varnish of collodion. A glass plate may be used instead of paper to receive the ink, and this, backed with another (opal) glass, gives an excellent result, suitable for a variety of ornamental purposes.

Mr. Woodbury has lately perfected a modification of his process, which is applicable to the representation in high relief of microscopic objects. The method consists in spreading a warm solution of gelatin, containing a little sugar and chromate of potash, over a glass plate previously coated with collodion. The film sets on cooling, and is then placed in contact with an ordinary photographic negative of the microscopic objects to be delineated, exposed to light, submitted as before to the action of water, and the soluble portions washed away. When the surface-moisture has evaporated, a mixture of plaster of Paris, containing a small proportion of alum, is poured over the relief to the thickness of half-an-inch, and left to set. When dry it will be found, owing to the alum in the plaster having hardened the surface of the gelatin directly on coming in contact therewith, to leave the gelatin easily, without any fear of adhesion. To give a finished appearance to the resulting casts, this intaglio, when dry, may be placed in a lathe, and a suitable border turned on it, which will be represented in the resulting proofs by a raised border, similar to what is seen on medallions or plaster casts. The name of the object may also be neatly engraved on the intaglio, to appear in raised characters on the reliefs. This intaglio should then be well waxed to fill up the pores, and is ready for taking any number of impressions in plaster; or a better plan is to take one in plaster, and having smoothed away any defects to mould a reverse in sulphur, which will give a greater number of fine impressions.

The author finally alluded to the subject of photolithography, as used in the photographic establishment of the War Department, at Woolwich.

Mr. Crookes then described his "New Polarizing Photometer."

GEOLOGY. (Section C.)

Although a large number of valuable papers were communicated to the Geological Section of the British Association at Dundee, there were few which, from their originality or largeness of conception, were calculated to leave a lasting impression on the minds of those present. There was no announcement of a new system of rocks—of a new theory of metamorphism—or of the annihilation of some generally received and cherished doctrine. The papers were on the whole fragmentary treatises on matters of detail—bricks and stones intended to occupy their special nitches in the temple of Science—and as such not without their value. Nor can we shut our eyes to the fact, that such must be the general character of the investigations of future geologists. Far be it from us to assert that this branch of Science is incapable of presenting new facts, and of giving rise to new speculations, regarding the past history of the globe and its inhabitants; but we are now sufficiently well acquainted with the order of succession of the groups and formations of rocks to feel satisfied that there is no room for the establishment of any new system of strata, such as the Silurian, the Carboniferous, or the Triassic; nor can we suppose that future discovery will materially alter our views regarding the order of succession of life on the globe.

The business of the Section was opened by a very instructive address from the President, Mr. A. Geikie, F.R.S., who, instead of drawing up a discursive essay on the science of Geology in general, limited his remarks—as we think wisely—to one special branch, to which his own attention has been specially directed. The subject chosen had reference to the successive periods in Geological time, during which there are evidences of volcanic activity in the British Islands. In this address the author showed "that from the massive feldspathic lavas and ashes of the Lower Silurian rocks, up to the great basaltic plateaux of Miocene age, most of our geological formations contain somewhere evidences of contemporaneous volcanic activity." Commencing with the sheets of felstone and tuff of the Lower Silurian period in Wales, which were first described by Sedgwick and Murchison, and have been mapped and described in great detail by the Government Geological Surveyors, the author gave a graphic sketch of the successive outbursts of volcanic activity during the Upper Silurian, Old Red Sandstone, Carboniferous, Permian, Triassic, and Tertiary Periods. To the Miocene stage Mr. Geikie refers the great trappean masses of Skye, the inner Hebrides, and the north of Ireland, as well as the dykes which traverse some of the rocks of the south-west of Scotland and the north of England. This view, which is in opposition to that of the late Professor E. Forbes, who referred them to the Oolitic period, Mr. Geikie founds on the fact, amongst others, that in Mull, masses of porphyritic and trachyte-like rocks, with a united thickness of over 3,000 feet, overlie beds with plants of Miocene species. Before passing on from the address, we are desirous of calling the author's attention to two points with reference to the age of certain outbursts of trap in England. Mr. Giekie may not be aware that in Leicestershire there is an instance of an outflow of trap which in all probability is referable to the Permian period. This rock occurs as a sheet of greenstone overlying unconformably the Coal-measures, and in turn overspread by Triassic strata, which are in no way affected by it. As it seems to have been erupted at a period between the Carboniferous and Triassic formations, it may be fairly referred to the Permian age, and is perhaps a solitary instance of contemporaneous trap of that period in England.

The other fact is, the occurrence of a dyke of greenstone, cutting through and indurating the New Red Marl in North Staffordshire. The knowledge of this case may induce him to modify a statement in which he says, " I am not aware of any satisfactory proof of contemporaneous volcanic rocks amongst the Secondary formations of Britain, save in the red sandstone of Devonshire, described by Sir H. de la Beche." The dyke here described must be referred in all probability to the Secondary Period.

Of the papers relating to Palæontology, one of the most valuable was that read by Dr. H. A. Nicholson, "On the nature and systematic position of the Graptolitidæ." The affinities of a family of animals of which we have no living representatives will, in all probability, remain a vexed question amongst naturalists. Professor Huxley places them amongst the *Polyzoa*, of the class "Molluscoida." Professor Owen amongst the *Hydrozoa*. The researches of Dr. Nicholson leads him to the conclusion that the family forms a link between the fixed and oceanic *Hydrozoa*, and in this view he appeared to be supported by Sir P. Egerton. As this paper will probably be published *in extenso* in some scientific periodical, it must be left to speak for itself. Mr. H. Woodward presented his third report on the fossil *Crustacea*, describing several new forms, a number of fine specimens of which were exhibited by Mr. Powrie, of Reswallie, and by Mr. R. Slimon. Mr. W. Carruthers gave the results of his investigations on fossil *Cycadeæ* at *Equisitaceæ*.

Much interest was excited when Dr. Oldham, F.R.S., exhibited a large map showing the progress of the Geological Survey of India, and explained the order of succession of the formations of that part of the British Empire, and their correlation with those of Europe. Considering the enormous extent of territory, the smallness of the staff of surveyors, and the physical difficulties to be encountered, the extent of country completed within the last fifteen years is surprising. According to Dr. Oldham's views the age of the Indian coal-fields, the whole of which are included between the parallels of 20° and 25° N. is Upper Carboniferous, of a rather later stage than that of the true Coal-measures of Britain, and more closely allied to the "fern-coal" series of Silesia. We have some doubts as to the correctness of this view, at least of the age of the Silesian coal-fields, which are known to rest on limestones containing large *Producti* and other fossils of the Carboniferous Limestone. Without entering farther on this inquiry, we here subjoin a brief summary of the formations of the Indian Peninsula, as described by Dr. Oldham, in ascending order:—

1. LAURENTIAN? Granitoid Gneiss—highly metamorphic, and traversed by innumerable trap dykes. This is the floor of all the other formations.
2. Quartzose, micaceous, and hornblendic rocks—much contorted.
3. LOWER SILURIAN, or CAMBRIAN.—Sub-metamorphic schists

and massive conglomerates of local rocks. These rocks occur in the Eastern Ghauts.

4. DEVONIAN.—The Vindhyan series, principally sandstones, distributed into four groups.
5. CARBONIFEROUS. — (*a*) Mountain-limestone of the Salt Range, classified as such from the fossils collected by Dr. Flemning.

   (*b*) The Talcheer series, sandstones of a peculiar character and colour, resting on a "boulder bed," or ancient shingle beach.

   (*c*) The coal-bearing rocks of India, forming the coal-fields of Damuda, Nerbudda, &c.
6. PERMIAN ? or intermediate.—Beds with reptilian remains, representing, in Dr. Oldham's opinion, the physical break between the Palæozoic and Mesozoic periods of Europe. We have ventured to indicate it here as doubtfully Permian.
7. TRIASSIC—Upper and Lower. In this latter there are beds of limestone with *Ceratites* (Muschelkalk ?).
8. RHÆTIC BEDS—with characteristic fossils.
9. LIASSIC GROUP—divided into an Upper and Lower Series.
10. JURASSIC GROUP—with *Cycadeæ.* Divided into Upper, Middle, and Lower Stages.
11. CRETACEOUS SERIES—with fine forms of Ammonites and other shells.
12. EOCENE.—(*a*) Nummulitic limestones.

    (*b*) Fresh-water deposits of lakes; over, and through, which sheets of lava have been erupted.
13. MIOCENE.—"Laterite," and other strata of several kinds.
14. PLIOCENE.—Ossiferous Gravels, Clays, &c.
15. RECENT.—Gravels, Clays, and Mud of Rivers, &c.

It is impossible to look over the above great series of beds, so truly representative as they are of the European system, and presenting often in minute detail a marked correspondence with our own subdivisions and formations, without being struck with the wonderful uniformity of Nature's operations in ancient times over vast portions of the globe. The stratigraphical resemblances are also not less remarkable than the palæontological, for the genera and some species of fossils of the Triassic, Liassic, and Cretaceous formations are identical with those of Europe.

The metamorphic origin of granite gave rise to a lively discussion, and several geologists pressed forward to make a public recantation of the erroneous doctrines they had once maintained on a subject on which some light was thrown during the discussion of Dr. Bryce's paper "On the Granites of Arran." The author maintained that the two kinds of granite, the coarse and the fine, in that island, had been erupted at different periods, and that the difference in their texture arose from the difference in their ages. This view, however, was opposed by Mr. E. A. Wünsch, who had accompanied Dr. Bryce during his explorations, and preferred to explain the differences in question by the differences in the texture of the original strata previous to metamorphism, a view which appeared to meet with general support.

While on the subject of Physical Geology we may refer to two papers, by Mr. E. Hull, F.R.S., relating to the North-West of England. In the first of these the author showed that the Carboniferous "sedimentary" rocks originally attained in the neighbourhood of Burnley, along the Pendle Range, a thickness greater than in any other part of Britain, and produced sections of the strata, in this and other districts, in confirmation of his views on the south-easterly attenuation of the Carboniferous "sedimentary" strata of the north of England. Taking four sections along a south-easterly line from Pendle Hill, the following were stated to be the comparative thicknesses:—

	North Lancashire.	South Lancashire.	North Staffordshire.	Leicestershire.
Coal-measures . . .	8,260	7,630	6,000	2,500
Millstone Grit Series .	5,500	2,500	1,000	50
Yoredale Series . . .	5,020	2,000	2,000	50
	18,780	12,130	9,000	2,600

The calcareous members are excluded from these sections, as having been deposited on a different plan.

In his second paper, Mr. Hull endeavoured to show that there were three consecutive periods of disturbance of great force affecting the Carboniferous districts of Lancashire. The first and the earliest took place before the Permian period, and produced the upheaval of the Lower Carboniferous rocks along the northern boundary of the Lancashire and Yorkshire coal-fields. The second resulted in the separation of the Lancashire and Cheshire from the Yorkshire and Derbyshire coal-fields, by the upheaval of the Lower Carboniferous rocks along "the Backbone of England;" and might be referred to the close of the Permian, or Palæozoic period. The third had produced the system of north-north-westerly faults which traversed the coal-fields, as well as the Permian and Triassic formations of Cheshire. This system of disturbances the author considered to be referable to the close of the Jurassic period. The directions of each of these three lines of disturbance were stated to correspond to the sides of a triangle, as follows:—

The 1st.	(Pre-Permian) lay in a direction .	E. 20° N.
The 2nd.	(Pre-Triassic) „ .	North—South.
The 3rd.	(Post-Jurassic) „ .	N.N.W.

The amount of denudation which took place in some districts of Lancashire during the first period was shown to have been in some cases prodigious. As an example: according to the calculations of the author and Mr. Tiddeman, his colleague on the Geological Survey, strata no less than 20,000 feet in thickness were swept away in the vale of Clithero before the Permian period.

An interesting discussion took place in reference to "Eskers," which is a name given to those lines of gravel found in various parts of Scotland and the North of England. Mr. Milne-Home, in describing a remarkable one in the valley of the Firth of Forth —which is clearly indicated on the Ordnance map—compared it with certain banks found by soundings under the Straits of Dover, as shown by the Admiralty charts. The direction of these submarine banks is found to correspond with that of the tides, and Mr. Milne-Home suggested that the Eskers of the valley of the Forth had been formed when that valley existed as a strait from sea to sea across Scotland, along which the tidal currents flowed.

In tracing the line of an old sea-terrace inland in the same district, Mr. Milne-Home stated that its surface was found to ascend towards the interior from the coast. Sir C. Lyell corroborated this observation, and stated that MM. Bravais and Martin had ascertained that along the coasts and fiords of Norway the old sea-beaches attain an elevation inland many feet higher than along the coast. In order to account for this, Sir C. Lyell threw out a remarkable suggestion. Referring back to the period when these terraces were in course of formation, and the land was submerged to a greater extent than at present, it seemed probable, owing to the proximity to the Glacial Period, that the mountains of the interior were covered by enormous masses of snow, which would exert naturally an attractive power on the waters of the fiords, drawing them up to higher levels in the interior of the country, and producing a corresponding rise in the position of the old beaches.

Mr. C. W. Peach, whose discovery of Lower Silurian fossils in the limestones of Duirness led the way to the reconstruction of the Geological map of the Highlands of Scotland, and enabled Sir Roderick Murchison to add to his many honours as an original explorer by the establishment of the Laurentian system as the base of the British formations, was present at the Section C, and read an interesting paper on some new forms of fishes from the Old Red

Sandstone of Caithness. Mr. Pengelly, F.R.S., the leader of the band engaged in the exploration of Kent's Cavern, Devonshire, produced additional evidence, if such can be required, that man was a contemporary with the mammoth in the British islands. Mr. George Maw, F.G.S., exhibited some very nature-like drawings of the Cambrian rocks of Llanberris Pass, lately exposed to view in the new railway-cutting connecting that pass with Carnarvon. In one of these sections an apparent unconformity was observable between two series of slate rocks, which, if confirmed by subsequent investigation, will prove a new feature in the Geology of that district.

We regret that space will not allow of further observations on several interesting papers, such as those of Dr. Collingwood on the coal-beds of Formosa, and Dr. C. Le Neve Foster on the Mines of magnetic iron-ore near Philipstadt in Sweden. Several papers of value received but scant attention, owing to the numbers which were set down for reading, and the shortness of the time which could be allotted to them for the purpose. Should this occur on future occasions, it may be necessary for the Committee to exercise discretionary power in rejecting some communications of minor importance, or such as deal with subjects of a purely speculative character, in order that due time may be given to those of a more substantial nature, and which contain observations new to Science.

BIOLOGY. (Section D.)

Section D this year met in two departments, one of Zoology and Botany, the other of Anatomy and Physiology. No application was made for an Anthropological department, and consequently no such department was formed. The authorities of Section E were averse to the formation of a separate Anthropological department, because Anthropology forms one of the most attractive and important subjects in their own Section. Next year it is not at all improbable that Section E will receive a new title indicating this fact, and Geography will very properly be made subordinate. A misunderstanding as to the suppression of the department somehow or other arose amongst the local Anthropologists, and the Dundee papers contained accounts of "indignation meetings" and an "Anthropological conference" to be presided over by Dr. Hunt. Matters were, however, eventually set right and the indignant persons acceded to the arrangements of the Association. Dr. Sharpey, Sec. R.S., Professor of Physiology in University College, London, was President of the Section, and kept to the department of Physiology and Anatomy; whilst Mr. George Busk, F.R.S., took the chair in the department of Zoology and Botany. Sir John Lubbock, Mr. Alfred Wallace, Mr Gwyn Jeffreys, Professor Newton (Cambridge), Professor Balfour (Edinburgh), Dr. Hughes Bennett, Professors Turner, Michael Foster, Cleland, Allen Thomson, and Dr. Richardson were amongst those who took part in the discussions. On Thursday morning the proceedings of the Section were commenced by an address from the President. Dr. Sharpey gave a very interesting account of the recent progress in Physiological Science, alluding to new discoveries, and the application of new instruments of research. He dwelt on certain practical matters, which he considered of great importance, such as the publication of records of progress, and of good and careful illustrations to memoirs. Besides having scientific functions, the British Association was the means of bringing together men in friendly intercourse, which he considered one of its most important offices.

Taking the reports and papers as we have done before in order of subjects, we commence with those on GENERAL ZOOLOGY and BOTANY. Mr. Spence Bate, F.R.S., read his "Report on the Marine Fauna and Flora of the Southern Coasts of Devon and Cornwall." He submitted lists of the various Mollusca, Annelids, and Fishes which had been obtained; his own attention had been directed to the Crustacea, of which he described some new species, and some highly interesting larval forms.

Mr. Gwyn Jeffreys, F.R.S., read his fourth report "On Dredging among the Shetland Isles." He recorded the occurrence of many interesting forms of Mollusca; and a preliminary report on other classes of marine animals, obtained by him, was furnished by the Rev. A. M. Norman. Dr. M'Intosh stated that Mr. Jeffreys had obtained for him a very fine lot of Annelids from Shetland, which filled 118 bottles, and promised to be one of the richest collections yet obtained. Mr. Jeffreys, in his report, made some remarks on the large size attained by species of Mollusca when living in boreal seas, as compared with that which they exhibited in more southern latitudes: he also drew attention to a ferret's tooth and some fragments of bone which had come up in the dredge; they had especial interest, as bones were hardly ever found in this way, and opened up the question of the corrosive action of the sea and its relation to the preservation of bones in a fossil condition. Mr. Busk considered this as a very important inquiry in relation to the antiquity of man; and suggested that experiments should be made as to the time and conditions of corrosion by the sea. Dr. Günther drew attention to the occurrence of some Madeiran species of fish amongst those obtained off Shetland. He could only account for their presence by the existence of a current running up from the latitude of Madeira along the west coast of Iceland, and bending eastwards towards Scandinavia.

Dr. M'Intosh read some notes on Annelids from the Hebrides, obtained by Mr. Jeffreys last year, amongst which were some new and interesting forms. The same gentleman also read a paper "On the Marine Fauna of St. Andrew's," which he had most carefully explored. To the Annelids and Turbellarians he had specially devoted his attention, and he exhibited some exquisitely finished drawings of these animals, which were highly eulogized by Mr. E. W. Cooke, R.A., who was present. He had obtained 104 species of Annelids and Turbellarians from St. Andrew's, of which several were new to Britain, and some new altogether.

Dr. Cuthbert Collingwood had no less than five papers on marine animals, which he had briefly observed in his recent voyage to the Chinese seas. They were as follows: "On Pelagic Floating Animals observed at Sea;" "Notes on Oceanic Hydrozoa;" "Observations on the Habits of Flying Fish;" "On Trichodesmium, or Sea-dust;" and "On some remarkable Marine Animals observed in the China Seas." These papers were chiefly interesting as containing personal observations on the habits of the creatures mentioned. Dr. Collingwood had a large collection of specimens in spirits which he submitted to examination.

Dr. Spencer Cobbold, in a paper "On the Entozoa of the Common Fowl and of Game Birds," gave his reasons for believing that the grouse disease was not in any way due to the presence of Entozoa. He described the species of flat, round, and tape-worms, which are to be found in these birds. His paper caused some discussion, in which the Rev. H. B. Tristram and Mr. Busk agreed in condemning the destruction of birds of prey by the game-keepers. Falcons and hawks act as nature's police, and check the spread of disease and epidemics amongst birds by killing off the weakly individuals of a covey.

Mr. C. W. Peach, a veteran zoologist who has done very much good work in dredging and exploring, read a paper "On some New British Naked-eyed Medusæ;" and another "On the Fructification of Griffithsia Corallina," found by him in Shetland.

Professor Alfred Newton read a "Supplement to the Report on the Didine Birds of the Mascarene Islands." The grant given by the British Association had been spent by Prof. Newton's brother in the most satisfactory way, for he had before him almost complete skeletons of the Dodo of the Island of Rodriguez,—the Solitaire. When the skeleton of the *Didus ineptus* of Madagascar had become known such a very short time since, it was highly satisfactory to obtain such complete evidence with regard to this allied species.

Leguat, who figured the bird some two hundred years since, mentioned that at the tip of the wing was a hard knob, as big as a musket ball, with which the bird could strike. The bones obtained by Professor Newton completely confirm this account, for a large bony knob is present on the free end of each wing-bone. Professor Newton considers that his new material quite justifies the establishment of the genus *Pezophaps*, proposed by Strickland on the very slender evidence he had at hand a few years since. The Dodo of Réunion yet remains to be investigated, and the French naturalists, it is hoped, will search out its remains. Mr. Busk remarked on the wanton destruction of the Dodo by men, and animadverted on similar destruction of rare animals and birds in our own country. Prof. Newton believed that the Dodo in Rodriguez had been destroyed by the herds of pigs which the sailors had left there,—a fat awkward bird like the Dodo would have but small chance against a hungry boar.

There was a fair number of papers on the occurrence, &c., of various plants. Mr. Carruthers, of the British Museum, read a paper on "The British Fossil Cycadeæ," in which he described some new genera and species, and pointed out the relation of the fossil Cycads to living plants.

Passing on (as our space compels us to do) we come to papers on ANATOMY.

Dr. Anton Dohrn, of Jena, made a highly interesting communication "On the Morphology of the Arthropoda." He was only able briefly to give the results of some extended researches in which he had been seeking to adopt the Darwinian hypothesis as a basis of classification. He believed that all Crustacea, Insects, Arachnida, &c., could be traced to a single parent form, which they each reproduced at one or other period of development; this form was identical with the larva of Cirripedes; and he gave it the name Archizoëa. All Arthropods had originally sprung from such a parent; and he endeavoured to show further how the various groups of that sub-kingdom were related in their descent. Classification means a genealogical tree to the disciple of Darwin; and the doctrine of "types" to him becomes intelligible. Sir John Lubbock and Mr. Spence Bate discussed certain parts of the paper, at some length.

Sir John Lubbock read a paper "On Some Points in the Anatomy of the Thysanura." Sir John has been working for some time at the Springtails, on the British forms of which group he is preparing a monograph for the Ray Society. Some of the drawings for this work, very beautifully coloured, were shown.

Mr. E. Ray Lankester described some new and important points in the "Anatomy of the Limpet;" which he had been investigating with Professor Rolleston, of Oxford.

Professor Turner, of Edinburgh, read a "Contribution to the Anatomy of the Pilot Whale." He described the anatomy of the stomach, the distribution of the great arteries which arise from the arch of the aorta, and some features in the cervical vertebræ of a specimen which he had dissected during the spring and summer of this year. The stomach of the pilot-whale was compared with that of the porpoise, and it was pointed out that in the former a greater number of compartments existed than in the latter.

Sir Duncan Gibb read a paper "On the Influence of Pendency of the Epiglottis upon Mankind at large." He had found that about eleven per cent. of Europeans had the epiglottis hanging down over the windpipe instead of erect; and he believed that such a condition prevented clearness in singing and speaking, and also produced a sluggishness of disposition, in consequence of retardation of respiration. Of 280 Asiatics (male and female) examined by him, all had a more or less pendent epiglottis, which was a very startling fact; and was probably connected with their incapacity for fine singing.

Professor Allen Thomson exhibited some "Microscopical Preparations of the Cochlea, of the Retina, and of Teeth of Fossil Fishes." He made a very important suggestion at the same time. Members of Section D had often found the inconvenience of exhibiting their microscopical specimens on the platform of the meeting room, where proper attention could not be paid to them, nor discussions entered upon in a satisfactory way. He proposed that at the next meeting of the Association a room should be set apart for microscopes, where members could examine specimens at their leisure, and confer with one another concerning them; other specimens of microscopic anatomy were exhibited by Professor Cleland, Professor Turner, and Dr. M. Foster.

We come now to the third head under which we arrange the papers read, *viz.* PHYSIOLOGY, the reason why structures and species exist, and how they exist.

Mr. Wallace had a most interesting paper "On the Relation between Sexual Differences of Colour and the Mode of Nidification in Birds." He ran over in detail the principal species of birds, having the female as beautiful and brilliant, or as conspicuous as the male. In cases where the female has this conspicuous appearance, the nest always conceals the female, and in cases where the female is of a dull colour, the nest exposes a considerable portion of the sitting bird. When the male bird is less brilliant than the female, it is found that the male performs the duties of incubation. There thus seems to be a connection between the colour of the different sexes of birds and the sitting over the eggs. There are some exceptions to this generalisation, but they can be easily explained, for these are generally protective colours. Mr. Wallace considered that Darwin's principle of natural selection most aptly explained this connection of colour and nests.

Mr. E. Ray Lankester drew attention to the "Boring of Limestone by Annelids" in a brief paper. He stated that, in the discussions concerning the boring of Molluscs, no reference had been made to the boring of Annelids—indeed, they seemed to be quite unknown—and brought forward two cases, one by a worm called *Leucodore,* the other by a *Sabella. Leucodore* is very abundant on some shores, where boulders and pebbles may be found worm-eaten and riddled by them. Only stones composed of carbonate of lime are bored by them. On coasts where such stones are rare, they are selected and all others are left. The worms are quite soft, and armed only with horny bristles. How, then, do they bore? Mr. Lankester maintained that it was by the carbonic acid and other acid excretions of their bodies, *aided* by the mechanical action of the bristles. The selection of a material soluble in these acids is most noticeable, since the softest chalk and the hardest limestone are bored with the same facility. This can only be by chemical action.

Dr. M'Intosh described a series of "Experiments with Poisons, &c., on young Salmon," in which he detailed the action on the heart, &c., of Aconite, Digitalis, Chlorine, and other poisons.

Dr. Ogilvie described the "Adaptation of the Structure of the Shell of the Bird's Egg to Respiration." He pointed out, in diagrams of various egg-shells, the existence of pores similar to the stomata of the leaf of a floating water-plant, the resemblance between which structure and an egg-shell is very remarkable.

Dr. B. W. Richardson had three papers,—one, his "Report on Methyl Compounds," in which he described the physiological action of several bodies allied to Chloroform, and recommended the Bichloride of Ethylene as a substitute for that anæsthetic. In another, "On the Coagulation of the Blood," he renounced the Ammonia theory, which he put forward some years since, and for his essay on which he gained the Astley Cooper prize medal. He now substitutes another hypothesis connected with some peculiar notions of his own on heat. In a third paper, he described some "Effects produced by applying extreme Cold to certain Parts of the Nervous System." By means of his Ether-spray apparatus he froze his arm and produced anæsthesia; he also produced torpor in a frog by freezing the brain; and he described experiments in which he had frozen various parts of the brain in birds—the freezing acting as effectually as excision, or even more so. The Ether-spray might, he considered, without doubt, be made a valuable means of research in this manner.

Dr. G. Robinson, in a paper on "Certain Effects of the Concentrated Solar Rays upon the Tissues of Living Animals immersed in Water," tried to show that it was not the calorific effect by which aquatic animals were killed when placed in a focus of sun light, but some other actinic or electric action.

Professor Hughes Bennett read two papers, one being an account of "New Investigations to determine the Amount of Bile secreted by the Liver;" the other, on "Protagon," a body which may be obtained by treating yolk of egg with alcohol—the chemical composition Dr. Bennett does not appear to know. This Protagon when placed in water assumes "cell-forms," and re-acts with acids and other re-agents, as many cells do.

Mr. E. Ray Lankester read a paper on "Observations with the Spectroscope on Animal Substances," and obtained a grant of 15*l.* to continue his researches.

Other Physiological papers were, by Dr. Polli, "On the Antiseptic Properties of the Sulphites;" by Mr. Wesley Bennet, "On the Influence of Fluids on the Body;" by Mr. Wentworth Scott, "On the presence of Quinine and other Alkaloids in the Animal Economy;" by Mr. Dunn, "On the Phenomena of Life and Mind;" and by Mr. Melville, "On Life—its Nature, Origin, &c." The last two papers were highly metaphysical, and called forth considerable discussion, though hardly rightly belonging to Physical Science at all.

We now have briefly to mention certain papers read which are of considerable importance, and come under our fourth heading of PRACTICAL papers.

They are—Mr. Andrew Murray, "On the Future Administration of the Natural History Collections of the British Museum;" Mr. W. Brown, "On the Claims of Arboriculture as a Science;" Dr. Lauder Lindsay, "On the Conservation of Forests in our Colonies;" "On Lichen Growth as a Criterion of the Age of Prehistoric Structures;" "On Lichen Growth as Detrimental to Forest and Fruit Trees;" "On Plant Acclimatization in Scotland, with special reference to New Zealand Flax;" Dr. Grierson, "On the Destruction of Plantations at Drumlanrig by a species of Vole;" Rev. H. B. Tristram, "On the Zoological Aspects of the Grouse Disease;" Sir James E. Alexander, "On the Preservation of Fishing Streams." Mr. Murray advocated the appointment of a single Crown minister who should be responsible for the management of the British Museum, instead of the irresponsible board of trustees who govern it now and who cannot be got at. He also advocated the exchange of duplicates and the better payment and increase in numbers of the staff of curators. Mr. Wallace, Mr. Busk, Mr. Carruthers, and others took part in a highly interesting discussion which followed, nearly all were opposed to the exchange of duplicates, but agreed with Mr. Murray in most other respects.

Mr. Busk, in remarking on the papers relating to Arboriculture, mentioned the fact that Gibraltar and Malta suffered from want of water simply because the trees had been cut down. This was also the case in Spain, and the importance of this matter could hardly be overestimated. Foreign governments had taken the matter in hand, and the art of the "forester" was carefully studied abroad.

Mr. Tristram, in his paper, drew attention to the folly of destroying birds of prey, since they checked the spread of disease among game-birds. The Duke of Buccleuch and Sir John Ogilvy concurred with the reverend gentleman, and considered that the game-laws ought to be extended to vermin in order to ensure the preservation of game. It is to be noted, however, that if there were no game-preserving at all, there would be no epidemics among game-birds.

Sir James Alexander's paper related chiefly to the local arrangements in Scotch Salmon-rivers.

Among the grants of money obtained by Section D, is one of 100*l*. to Sir John Lubbock, to assist in the preparation of the 'Zoological Record,' of which we have had to speak so well before in these pages.

A recommendation on the management of the Natural History Collections of the British Museum was also forwarded to the Parliamentary Committee by Section D.

GEOGRAPHY AND ETHNOLOGY. (Section E.)

This Section sat on five days, from Thursday, September 5, to the Tuesday following, including Saturday, when every other Section adjourned for the excursions. The place of meeting was the Great Hall of the new Albert Institute (of which Mr. Scott is the architect), a fine apartment, with a very beautiful and simple Gothic-arched roof, but so ill-adapted for hearing that only one or two speakers with exceptionally powerful voices were ever audible beyond the centre of the room. As is usually the case, this Section was better attended than any other, although the acoustic deficiencies of the Hall prevented it from being so well filled as it otherwise would have been. The first meeting was particularly well attended to hear the President, Sir Samuel Baker, deliver his opening address, he being almost the only man present at this meeting of the Association who excited any unusual interest, or could aspire to the reputation of a "lion."

Every one must have noticed the tendency of many speakers at Dundee to adapt themselves to the prevalent theological opinions of the Scottish people, and certainly either Sir Samuel Baker has much narrower views on these subjects than most men of such a wide experience of life, or he illustrated in a remarkable manner that capacity of being "all things to all men," which is perhaps an essential part of a successful traveller's character. His address was a long one, occupying three quarters of an hour of rapid speaking. It was well written and eloquently delivered, and though a captious critic might object that it contained too frequent references to his own travels and too much glorification of the Royal Geographical Society, it was always interesting and sometimes instructive. A few extracts will best illustrate those references to religion which were so frequently indulged in, and which, however questionable in point of taste, were well received by the local portion of his audience.

"Theology is closely interwoven with the study of Geography; the history of man from the remote beginning is linked with a description of the creation of the world, when God said—'Let us make man in our own image.' From that time the very elements of our creed are connected with particular positions upon the earth's surface. The most important events that have influenced the march of civilization and the spread of Christianity have occurred in certain places that throw intense interest upon the science of geography. The wanderings of certain nomadic tribes seeking for new pastures for their flocks have brought to light new countries, and have implanted new religions. The arrival of Abraham from Chaldea, the simple Arab chieftain with his followers, who settled in a new country, laid the foundation of our Jewish history, followed by those mighty events, at distant intervals, the Exodus from Egypt, the building of Jerusalem, the birth of Christ, the Roman conquest; until at length by the victories of Cæsar, the West was rescued from its savagedom, and the road was opened to Great Britain, to be followed by the light of truth. All this wonderful train of progression is based on geography."

The papers read on the first day's sitting were very inferior and uninteresting, and excited very little discussion. One by Captain Maury on the "Physical Geography of Nicaragua," repeated those views on the "great equatorial cloud-ring," which are to be found in his published works, and have so frequently been explained in public. Mr. Crawfurd's paper on the "Australian Aborigines" was no doubt a useful summary for visitors, to whom his ideas and style were novelties, but contained nothing worthy of a permanent record.

On Friday Sir Roderick Murchison's promised exposition of his views respecting Livingstone's fate, attracted a crowded audience and excited much interest. He went over a great deal of ground, giving a general sketch of the discoveries of Burton, Speke, and Baker, and arguing that on general grounds it was not likely that a man like Livingstone, who had gone across Africa on foot, with no assistance except from natives, should fail on an expedition in which he was assisted by Government and backed by the Royal Geographical Society. This argument, however, is transparently weak (since no precautions can guard a man in a strange country from the attacks of the natives), and Sir Roderick therefore lays most stress on the known bad character of Moussa, the Johanna man, who is the sole witness to the fact of Livingstone's murder, and on his having given two inconsistent versions of the story. Sir Samuel Baker, on the other hand, whose knowledge of African character and habits can hardly be disputed, admits that Moussa, like most natives, is a great liar, but says that it is for this very reason he believes him. The paradox is easily explained. The natives are skilful and artistic liars, and one of the canons of their art is, never to tell a lie of which you may be any day convicted. No native would ever run away from his European master, and exculpate himself by saying he saw him murdered, because the very next day or week his master might return and convict him of a lie, as well as of cowardly desertion. From the nature of the country and the character of its inhabitants, the fact of a traveller being murdered by them is in itself probable, and when his chief native guide says he saw it done, the evidence is to be relied on, because it would be too inartistic and easily disproved a falsehood for a clever native to be guilty of.

The only other papers that were of any interest this day were those on Palestine, by Captain Wilson, of the Palestine Exploration Fund, Lieutenant Anderson, and the Rev. H. B. Tristram; but they contained little matter of note beyond an account of the progress in mapping the country round Jerusalem, and the discovery of some fine architectural remains, and the system of aqueducts by which the city was supplied with water.

On Saturday Mr. Crawfurd did his best to supply both instruction and amusement to those who did not go on the excursions, by reading three papers, all of which excited some discussion. The first was on the Antiquity of Man, and was a resumé of the main arguments on this subject, interspersed with Mr. Crawfurd's peculiar views on language and on the dependence of man's mental and physical condition on the country he inhabits. He adverted to the evidence of a high civilization at a very early period afforded by the pyramids of Egypt, which the best authors considered to be more than 5,000 years old; to the unknown antiquity of the distaff and the loom; and to the proof afforded by language of the remote origin of mankind.

Sir John Lubbock showed that Mr. Crawfurd had understated the number of actual remains of man which had been found in such positions as to show that they were contemporary with extinct animals, coeval with the makers of the most ancient flint implements, and of such a high antiquity that the period of actual history sinks into comparative insignificance. He concluded by remarking that it had been said that certain papers had been refused at this meeting, because the British Association did not wish to excite feelings of hostility on the part of the people of Dundee,—but he thought that the paper to which they had just listened was a very good answer to any remark of that kind. He was quite sure that very few people would suppose that the British Association would pay so bad a compliment to the inhabitants of this part of our island as to suppose that they would meet with a different reception here from that which they were accustomed to meet with elsewhere in discussing such questions, and it was a very bad compliment, either to the people of Dundee or to the members of the British Association, to suppose that these interesting and important questions could be discussed in any other spirit than that in which they had been ventilated in other parts of Great Britain.

Dr. Hunt objected to Mr. Crawfurd's statement that the earliest men were speechless, and said that he could not apply the term "man" to a race of beings without speech. He also adverted to the fact that Bunsen, a great authority in favour of the unity of man, had said it was utterly impossible to explain it in less than twenty thousand years. Mr. Crawfurd caused some amusement in his reply, by stating that all the facts relating to the geological history of man which Sir John Lubbock had criticized were taken out of Sir John Lubbock's own book, and concluded with his usual ridicule of the "unity" theory.

Mr. Crawfurd's next paper was on "Skin, Hair, and Eyes as Tests of the Races of Men." Of these he seemed to think the colour of the skin was the most important, while Dr. Hunt maintained that the character of the hair was extremely valuable, and both agreed that we have yet no evidence whatever as to the causes which have produced these peculiarities, although they were certainly not the effects of climate alone. The only attempt at generalization was made by Dr. Hunt, who stated that "a dark colour of hair and eyes, combined with curly hair, was always a mark of mental inferiority," and challenged anyone to bring forward an exception.

Mr. Crawfurd's last paper was on a subject of which the popular knowledge is very scanty:—"The supposed Aborigines of India as distinguished from its Civilized Inhabitants."

"In many parts of India there existed," he said, "rude and even savage tribes, differing widely in manners, customs, religion, and not unfrequently even in language, from the great body of the civilized inhabitants. People in that state of society were found only in hilly or mountainous districts, more or less inaccessible, and by their comparative sterility holding out little temptation to conquest and occupation. They were never seen in the fertile and well-watered alluvial valleys of the great rivers, which, on the contrary, were inhabited by civilized nations, however differing among themselves in manners and language. Linguists and craniologists had invented a theory to account for this state of things, which supposed the rude mountaineers to be the sole aborigines of India, while it imagined the civilized inhabitants to be intrusive strangers, who in a remote antiquity invaded India, conquered it, and settled in it under the imposed names of Aryans for Northern, and Turanians for Southern India." This view appeared to him utterly groundless, and he went into a lengthy description of the history of the people, their manners and mode of life, and quoted several accounts of the several tribes, in order te refute the view which he had mentioned. After an elaborate paper he concluded:—"The mind may safely carry us back to a time in which the social state of India was similar to that of America, when the civilized tribes were few in number, and the wild or savage formed the majority. The Hindu is, beyond all question, a far more highly endowed race of man than the Red man of America; and civilization would probably spring up earlier, at more points, and attain a higher maturity in India than it did in America. We may even point at the localities in which civilization is most likely to have had its earliest seats. Separate and independent civilizations would probably spring up in the plains watered by the 'Five Rivers,' in the upper valleys of the Jumna and Ganges, in the central and in the lower valley of the Ganges, and in the valleys of the rivers of Southern India, such as that of the Nerbudda, the Godavery, the Kistna, the Cavery, and the Taptee. These nascent civilizations would be independent of each other, and for a long time be as unknown to each other as were the Mexican and Peruvian. All this most probably happened long before there was an Aryan invasion, or a religion of Bramah. The state of India at such a time would be a parallel to that of America on its discovery; the wild and savage tribes would be numerous, and the civilized few in number. Proportionate to its extent, it would have as many small tribes, speaking as many distinct languages as America itself. India has still a score of nations with written languages, but the number of its wild tribes have not yet been counted."

Altogether, although containing no original matter, we must admit that Mr. Crawfurd's papers were well adapted to excite interest on some of the great questions connected with the study of man, and may do more good among the visitors to the Association than the papers contributed by those scientific workers who, by their researches or discoveries, have contributed their quota to the mass of human knowledge.

On Monday morning considerable expectation was excited by the announcement of a paper by Sir John Lubbock on "The Early Condition of Man," which was the first on the list. The paper was evidently composed expressly for a Scotch audience, and though many of the scientific members of the Association thought it was too much like crushing a fly with a sledge-hammer, the sequel showed that Sir John had well estimated the state of knowledge and feeling of his audience. The paper was a careful and elaborate refutation of the doctrine advocated by Archbishop Whateley, that man never could and never did emerge unassisted from a state of utter barbarism into anything that can be called civilization, and that all savages are the degenerate descendants of more civilized peoples. Numerous cases were adduced to show that savages do advance, and the absence of cultivated plants or domesticated animals run wild in any country inhabited by savages was strongly insisted on, since we know that when now introduced by civilized man these species do spread and maintain themselves often to the extermination of native races. So the absence of pottery is a conclusive proof that savages have not descended from civilized races, because pottery is indestructible, though easily broken. The absence of terms for the ten numerals in so many savage languages was another proof of their original barbarism, since these were such useful and such simple terms that we cannot imagine them if once known ever to have been forgotten. Again, the stone weapons found in civilized countries getting ruder and ruder as they can be shown to be older and older, proves the same thing, as do the relics of barbarous customs traceable even among the most civilized of modern nations.

Professor Busk raised the previous question of "What is Civilization?" It can be variously defined, and in some respects the moderns have not advanced beyond the Ancient Greeks.

The Rev. H. B. Tristram made several objections, and asserted his own belief in the theory of degradation. Dr. Hunt said that this was the first really scientific and satisfactory reply that had been made to Dr. Whateley, and he was surprised that any member of the British Association could be found who supported the same views. He disagreed, however, from Sir John Lubbock as to there being any nations who had raised themselves, and asked that they should be pointed out.

In his reply, Sir John Lubbock said that the fact that Dr. Whateley's views had been supported in that room showed that the present paper was not so unnecessary as Mr. Crawfurd seemed to suppose. As to defining "civilization," he thought his friend, Professor Busk, was a very good specimen of a civilized man, and he named the Chinese, Mexicans, and Egyptians as nations who had raised themselves without external assistance to a certain amount of civilization.

It may be remarked, that in the next morning's issue of the 'Dundee Advertiser' the editor expressed his surprise "that no local man stood up to confute the theory of man's original barbarism; for no one who believed that Adam was created a civilized being could have received Sir John's theory of man's creation without a protest."

The next paper was one by Dr. Davy, on "The Character of the Negro," which excited more warm discussion than had yet been raised. Dr. Davy vindicated the Negro against the charge of inveterate idleness, and showed that, under sufficient stimulus, he was as industrious as most European labourers. The discussion diverged into the moral and intellectual character of the Negro, most of the speakers maintaining that whenever a supposed Negro exhibited any marked mental superiority it was due to his having an admixture of white blood in his veins.

On Tuesday morning Sir Roderick Murchison gave notice that "The International Congress of Anthropology and Prehistoric Archæology" proposed to hold its session in England in the year 1868, and that the Presidency had been offered to himself. He had, however, declined that honour, on the ground that Sir Charles Lyell, Sir John Lubbock, and several other eminent men had devoted much more time and study to that branch of Geology than he had done.

The indefatigable Mr. Crawfurd then again appeared with a paper on "The supposed Plurality of the Races of Man," in which he maintained that there was no proof whatever that the races of mankind had been derived one from the other; and went into a long discussion of the facts relating to domestic animals, which, he maintained, showed that the arguments for the unity of man were fallacious. The Chairman, Sir Roderick Murchison, then called attention to the fact, that neither Mr. Crawfurd nor himself were Darwinians; and Mr. G. Vivian made a long and elaborate speech, in which he controverted Mr. Crawfurd's views both on geological and theological grounds, and expressed his own belief in a limited form of Darwinism. Mr. Wallace followed with an attempt to disprove Mr. Crawfurd's theory, by showing,—first, that accepting the facts adduced in the paper, all fair analogy from domestic animals and plants in those cases where we know their history best, is in favour of the unity of man. Secondly, that the known migrations of mankind render his diffusion from a single origin a matter of no difficulty; and thirdly, that, accepting the fact of man's immense antiquity, and the laws of variation and survival of the fittest, which Mr. Darwin had shown to exist throughout all organic nature, it was easy to understand how the varieties we now find could have been produced. Mr. Crawfurd replied by ridiculing the theory of the development of monads into monkeys and men, which he persisted in attributing to Mr. Darwin.

Mr. Crawfurd, then read another paper on the "Migration of Sugar-producing Plants," which caused no discussion; after which a vote of thanks was passed to the author for the numerous papers he had contributed.

The proceedings of this Section terminated by the reading of a paper of much interest, "On the Wild Indians of Peru," by Antonio Rainioudi, Professor in the University of San Marcos, Lima. These Indians were called Campas. They made only a shelter of leaves for houses; the men were idle, the women slaves. Their language was full of vowels; they could only count to four. They had no idols or religious ceremonies, and threw their dead into the river with a stone tied to the body to make it sink. The posterior part of the cranium was much developed as compared with the anterior part, the orifice of the ear being thrown much forward, and the author thought the position of the ear was of much importance in comparing the intellectual development of different races.

As a whole, the proceedings of this Section were somewhat below the average of interest. The only complete and carefully prepared papers were those of Sir John Lubbock on the "Early Condition of Man," and Mr. Crawfurd on the "Races of India,"—while the former alone could lay claim to any connected and exhaustive reasoning. The want of some preliminary arrangement of the papers was also seriously felt. On each of the subjects of "Palestine" and the "Isthmus of Panama," there were several papers which, if grouped together and cut down to the really original and interesting matter in each, might have furnished interesting matter for a day's discussion. These were, however, read for the most part separately, and weary repetitions of uninteresting and well-known details formed their prominent feature. The Ethnological papers and discussions were those from which the people of Dundee probably derived most amusement and information, as well as some new and, to them, startling ideas.

MECHANICAL SCIENCE. (Section G.)

Instead of opening the business of the Section by a formal address, the President, Professor W. J. M. Rankine, recapitulated the principal points in the history of the work done by the Section since the year 1850, when he joined the British Association, believing that work to be the most important which consists in receiving reports of scientific researches made during the previous year, and in planning those to be made during the ensuing year, whether by observation and experiment, or by collecting and arranging existing information.

He classified the subjects of the reports in a masterly manner, and in several instances paid deserving compliments to the persons who had instituted experiments and compiled the reports named. The following is the classification of the contents of the Reports:—

I. Strength of Materials.
II. Motive Power.
III. Hydraulic Engineering.
IV. Shipbuilding and Steam Navigation.
V. Conveyance.
VI. Metallurgy and Agricultural Machinery.
VII. Weights and Measures. 1864–5–6.
VIII. Patent Laws. 1858–9, 1861.
IX. Scientific Evidence in Courts of Law. 1866.

The first paper read was an abstract of a Report on the "Condensation and Analysis of Tables of Steamship Performance," as published in the years 1857, 1858, 1859, 1860, 1861, and 1862. The Committee (appointed at Nottingham in 1866) being J. Scott Russell, William Fairbairn, Thomas Hawksley, James R. Napier, and W. J. M. Rankine. The large collection of the records of steamship performance has now been rendered useful for practical and scientific purposes by this Committee. The data contained in those records have been condensed and re-arranged according to a method, the leading principles of which may thus be summed up:—All results belonging to any special theory, and all quantities calculated by inference, or ascertained otherwise than by direct measurement, are excluded from the condensed tables; vessels for which certain essential data are wanting are excluded (the essential data being such as the principal dimensions, displacement, kind of propeller, speed, indicated horse-power, &c.); the vessels inserted in the condensed tables are divided into groups, according to their full speed, and very numerous groups are subdivided according to the displacement; a uniform arrangement of the data is adhered to as far as practicable; and the tables are drawn up in such a form as to be printed in octavo pages.

Mr. J. V. N. Bazalgette drew the attention of the Section to the desirability of placing permanent topographical indicators on those mountain summits which are visited by tourists, so that they may be supplied with reliable information regarding the direction, distance, &c., of objects of interest visible from those summits, and in the case of mountains, their heights above the sea-level. The author recommends a circular table of stone or metal, on which circles and radial lines should be engraved, showing in one case the distances, and in the other the directions of the objects to be looked for. A district thirty miles in radius would generally be found sufficient, and for the names of all the objects of interest embraced within that area a table of three feet would probably suffice. Mr. Bazalgette also recommends that a revolving telescope be fixed in the centre of the table, and a light ornamental place of shelter, both for the indicator and the tourists. Such an indicator is being erected by Mr. Bazalgette on the summit of the Malvern Beacon Hill, Worcestershire, an elevation of nearly 1,500 feet above the sea-level.

The President highly commended Mr. Bazalgette's recommendation as being simple and likely to be extensively followed, and hoped the people of Dundee would show their appreciation of it by forthwith erecting an indicator on the Law of Dundee, an admirable place for such a useful thing.

"The Construction and Works of the Highland Railway" was the title of the next paper, the author of which was Mr. Joseph Mitchell, C.E. It embraced an elaborate account of the difficulties encountered in constructing the railway, and many very valuable data regarding the works. The Central Railway from Dunkeld to Forres, is a single line 104 miles long, with 8 viaducts, 126 bridges over streams, 119 public and accommodation road-bridges, and 1,159 covered drains, from 18 to 36 inches square. The total cost per mile was 8,860*l.* The future utility of this railway may be estimated by the fact that in one week the Company carried no fewer than 21,000 sheep over it. The summit of the line is 1,500 feet above the level of the sea, or 500 feet higher than the summit of the Caledonian line. Notwithstanding its high northern latitude and its exposure to snow-storms, those of last winter in no way interrupted the traffic on the Highland Line, and yet the traffic on other lines in Scotland, England, and France was stopped for a length of time varying from 12 or 16 hours to five or six days. On this line screens are erected to intercept the snowdrifts in exposed places, and where these are not sufficient snow ploughs are used, one of them being able to clear a depth of 10 or 11 feet of snow with the aid of four or five goods-engines. Another branch of the Highland Railway, from Invergordon to Bonar Bridge, 26½ miles long, has been constructed at a total expense of 5,888*l.* per mile.

Professor Rankine, in proposing a vote of thanks to Mr. Mitchell for his paper, said it was one of the most interesting that would come before the Section, as the information contained in the great collection of facts relating to bridges would be most valuable to civil engineers in preparing estimates for new works. The Highland Railway passed through such a rugged description of country that the difficulties of construction were very great. Looking at the diagrams furnished by Mr. Mitchell, the substantiality of the works, the moderate cost of execution, and the remarkable judgment with which the various works had been suited to the different situations must have struck every civil engineer in the room.

The next communication was by Mr. John Fernie, of Leeds, on "The Iron and Steel at the Paris Exhibition." Mr. Fernie considered that the great duty imposed on British manufactured iron now imported into France amounts almost to a prohibitory tax, while raw iron is admitted at a very small duty, and coal duty free. He thought that France had not surpassed Britain in iron-making in any of its departments, but that Krupp and the Bochum Company had shown larger masses of steel than England had as yet manufactured, and that the Bochum Co.'s cast-steel railway-wheels were the finest ever exhibited. The President, Mr. Foster, and Mr. Ferdinand Kohn (of "*Engineering*") joined in an interesting discussion on the subject raised by Mr. Fernie's paper. At a subsequent sitting of this Section Mr. Kohn also read a paper on the subject, specially referring to the interest and curiosity excited by the extraordinary sizes and qualities of the steel castings of Rhenish Prussia, and by the secrecy and mystification surrounding their manufacture. A professional survey of the Paris Exhibition, extending over many weeks, had led him to conclude that there was no ground for the notion that the predominance and superiority of the British iron-manufacture had ceased to exist, or were threatened to be overthrown by continental competitors.

Mr. David Greig, of Leeds, read a paper on "Steam Cultivation: Advantages derivable from it, and its Present Position and Future Development." It was full of interest and instruction, Mr. Greig's opinion is that the generality of land, if put under steam-cultivation, and kept free from the trampling of animals, would only need one deep working every fourth or fifth year. He confidently expects that, with remodelled farms, the use of the best engines and machinery, and the employment of men educated to superintend them, the expense of cultivation would be reduced to one-half of the present cost. Mr. Fernie said that the best way of avoiding the breakages of machinery referred to by Mr. Greig, was to introduce the use of steel, and properly tested wire rope. The first wire rope was worn out with 300 miles' work, but rope now made of steel wire will do fifty times as much work.

The Rev. Patrick Bell, of Carmyllie, Forfarshire, the original inventor of the reaping machine, read a paper on "Reaping

Machinery." It was a most graphic account of the history of his experience, which, in the year 1826, led to the invention. Mr. Fairbairn stated that he had been engaged at the Paris Exhibition to report on reaping machines, and that he had seen 15 or 16 machines tried on a large farm, and that the best, an American invention, differed but very little from Mr. Bell's.

Mr. J. Clerk Maxwell's paper on "The Theory of Diagrams of Forces as applied to Roofs and Bridges," was very theoretical, and had an interest for but a limited number of persons.

In reference to the Report of the Committee on the Patent Laws, the President announced that it was not ready, owing to the absence of the members in London and Paris, during July and August, but considerable progress had been made with it, and the Committee was re-appointed.

A highly important paper was read by Dr. W. Fairbairn on "Experimental Researches on the Mechanical Properties of Steel in its present improved state of Manufacture." The introduction to the paper gave a condensed history of the improvements lately made in the manufacture of iron and steel, and referred to the attempts to substitute steel for iron in the construction of boilers, bridges, &c., on account of its greater tenacity and security. Dr. Fairbairn discourages the placing of too much reliance on steel until the present difficulties of its manufacture are surmounted, and until it can be produced with as much uniform certainty as iron. Time and close observation of facts would overcome the difficulties now experienced. The author's experiments had been specially directed to the determination of the following points:—1. Transverse Strain. 2. Tensile Strain. 3. Economic use of Material. 4. Compression. 5. Comparison of Tensile and Compressive Resistances; and they had enabled him to announce many results of the utmost importance.

One of the very few representatives of American science at Dundee was General Haupt, whose boring and tunnelling machine has recently excited a large amount of attention in this country. The inventor gave a full and elaborate description of his machine, and illustrated it by diagrams. The machines weigh 125 lbs. each, are only 30 inches long, 6 inches wide, and 8 inches high. On the subjects of power by compressed air, ventilation, and use of steam in tunnelling, General Haupt's statements excited much interest, and drew forth very complimentary remarks from General Lefroy, Dr. Fairbairn, and the President, the latter expressing a hope that he would again favour the British Association with his presence. Dr. C. Le Neve Foster followed General Haupt with an account of a boring machine used at the Preseberg Mines in Sweden.

A paper by Mr. Joseph Mitchell, C.E., on "A New Mode of Constructing the Surface of Streets and Thoroughfares," excited some attention in Section G. Mr. Mitchell's new plan is to lay down a bed of three inches of cement-concrete to the required convexity of the street, and then to build on this bed a layer of paving-stones five inches deep and three inches wide, filling up the joints with cement-grout. As tested in Inverness and on George IV. Bridge, Edinburgh, this new system has proved so successful that many advantages are claimed for it as regards durability, cleanliness, repairs, &c. Mr. Mitchell recommends the best Portland cement for the concrete.

"An Iron Camb for Power-Looms" was the subject of a paper by Mr. James K. Caird, of Dundee. One was read by Sir Edward Belcher on "The Methods for Testing the Speed of Vessels over the Measured Mile;" another, by Mr. J. R. Napier and Professor Rankine, discussed "The Use of Movable Seats for Slide-Valves;" and one by Mr. Lewis, of Dublin, had for its subject "An Improved Marine Steam Boiler." Mr. S. J. Mackie also read a long and elaborate paper on "Iron Floating Forts, Iron Harbours, and other Floating Structures, and on Daft's Method of Construction of Iron Fabrics." Other papers of more or less interest followed, and there were also two of a mechanical character read in Section F, because they were considered to be of an economic or statistical character: their subjects were "The Engineering Trade of Dundee," and "The Iron Shipbuilding of Dundee."

THE PUBLIC HEALTH.

(With the Proceedings of the Health Section of the Social Science Association.)

Whatever may be the result of the elections to Parliament under the new Reform Bill, there is one comfort in the prospect that our sanitary legislation can hardly get to a lower ebb than it is just now. It is perhaps to be hoped that as the people who have now the electoral power conferred upon them are those who suffer most from bad sanitary arrangements, this subject will not wholly escape their attention in the selection of candidates to represent them in Parliament. If this be the case we may hope to see some men returned who have a notion of the value, economically we mean, of human life, and who will apply themselves to introducing law and order into that chaos of conflicting legislation, which a well-meaning but incapable legislature has introduced for the purpose of preserving the health and lives of Her Majesty's lieges.

In our last number we referred to the Vaccination Bill and Mr. Torrens's Artizans' Dwellings Bill: the latter was withdrawn at the eleventh hour from pressure of business, whilst the former is now passed into law with all its defects. It is to be hoped that it may do good. It is, however, encumbered with a principle that is new to our legislation. Should the medical profession agree to take the Government eighteen pence for vaccination, if they do the thing well at this price, they are to have the chance of getting rewarded by an extra payment. The "payment by result" scheme of South Kensington is to be tried in vaccination, and the medical men who do this duty very well are to be rewarded as good boys at school,—with prizes. This plan is nothing more nor less than an acknowledgment that the sum offered for vaccination is no professional recompense, and that if medical men will undertake the operation for the small sum offered, they shall be rewarded if they perform it properly, which there is no right to expect at the price they are paid. We hope the medical profession will universally spurn this bribe, and show the Government that they can perform their duties without such a stimulus. We should like to see the President of the Privy Council, its Vice-President, and Medical Officer put on a system of "payment by results," before it is introduced amongst the great body of the medical profession.

The ninth annual report of the medical officer of the Privy Council has been printed, and two journals, the 'Pall Mall Gazette' and the 'Lancet,' have had notices of it, but up to the present time no copy of the report can be obtained at the Queen's printers. Mr. Simon is said to give an elaborate account of the stages by which the present Vaccination Bill has assumed its present form, and also a defence of the presentation of gratuities for results.

The most interesting portion of the report appears to be the appendix, in which is published a paper by Dr. Buchanan "On the Results of Sanitary Improvements, as applied to the Large Towns of England." The 'Lancet' remarks on this paper, without giving any reason for its opinion, that it "is undeniably one of the most important contributions to State-medicine which has been made for many years." In a postscript to his report Mr. Simon gives an account of his visit to the International Cholera-conference at Weimar. We quote from the 'Lancet' the conclusions at which Mr. Simon arrives. The local conditions of safety against cholera, and we may add typhoid fever, are—

"1. That by appropriate structural works, all the excremental produce of the population shall be so promptly and so thoroughly removed that the inhabited place, in its air and soil, shall be absolutely without fæcal impurities; and 2, that the water-supply of the population shall be derived from sources and conveyed in such channels that its contamination by excrement is impossible."

The last volume of the 'Transactions of the Social Science Association' contain two papers "On the Medical and Legal Aspects of Sanitary Reform," by Dr. A. P. Stewart and Mr. E. Jenkins, which have recently been published by Mr. Hardwicke in the form of a pamphlet. Dr. Stewart's paper is the result of a very elaborate inquiry into the sanitary condition of our large towns, and contains a number of tables giving a summary of information obtained by sending a series of printed questions throughout the country. The impression produced by the study of Dr. Stewart's paper is very painful. Throughout the length and breadth of the land people pay no attention to the prevention of disease and death. The local authorities neglect to put in operation the provisions of the various Health Acts. A list is given of thirty-six towns in England (at the head of which is Birmingham, with a population of 340,000), containing above two and a half million of inhabitants, in which there is no medical officer of health. In many of these towns there is a death-rate of from 25 to 30 in the 1,000; in a large number the drainage is imperfect; and in many typhoid (drain) fever is never absent. Water is constantly supplied from wells in communication with cesspools, and in many instances water is supplied for public use, known to be contaminated with sewage. That decent English people, cultivating in many cases the excessive refinements of life, should allow themselves to live, and their families to grow up, amongst such a mess of nastiness is astonishing, and one is at a loss to know how to reach them to warn them of their folly and their danger. Dr. Stewart recommends the appointment of "a thoroughly efficient administrative department of government for the superintendence of all matters relating to the public health," and the "appointment of officers of health, not only in towns but in the country, and for our ports and harbours."

Mr. Jenkins commences his paper by a truism, which, one would think, should have stirred even the apathy of a London vestry,—"PUBLIC HEALTH IS PUBLIC WEALTH." This sentence should be printed in letters of gold over every vestry-house, every corporation-hall, and every law-court in the kingdom. It is the law of human civilization, and is the key to all human progress. Mr. Jenkins shows very ably in his paper, how wretchedly all our sanitary laws fail on account of their permissive character; and how, by the indifference and ignorance of local boards, the health and wealth of the community are sacrificed.

We are glad to be able to say that a medical officer is *at length* about to be appointed by the Manchester authorities, who are trying to justify their opposition to the Artizans' Bill by attacks upon Mr. Torrens. The truth is, that if the Manchester Corporation had been as zealous in promoting as they were in opposing Mr. Torrens's measure, he would not have been obliged to defer it until next Session.

In strange contrast with the conduct of the Manchester Corporation, we may add that a memorial was sent up to Lord Derby (through Lord Stanley, who interested himself in this, as he does in every effort to promote the welfare of the masses), signed by leading sanitarians in Leeds, Liverpool, Manchester, and Oxford, to urge the passing of the Bill; and, if needful, the same gentlemen will repeat their efforts in co-operation with Mr. Torrens next year.

There is some little satisfaction in witnessing the wretched attempts at justification put forward by the Manchester authorities, for it shows that at least they are conscious of having done wrong, but we hope soon to see some more creditable evidences of their desire to protect the health and lives of their citizens. They have acted upon the principle usual with corporations: to resist reform until public opinion seemed likely to overwhelm them, and then, tardily complying with the public requirements, have comforted themselves by abusing their friends and advisers.

The Social Science Association held its Eleventh Annual Meeting this year at Belfast, under the presidency of Lord Dufferin. The session was opened by an address from the President, which dealt very boldly with the social grievances of Ireland. As no allusion was made by his Lordship to public health, a subject on which our legislators generally seem to take very little interest, we need not refer to it further here. Sir James Simpson, of Edinburgh, had accepted the office of President of the Health Department, but unavoidable engagements prevented the Doctor from taking the chair the first few days of the Congress. According to the plan generally adopted by the Association, certain questions were proposed to be discussed, and papers bearing on them read. The chair was taken on Thursday by Dr. Lankester, who opened the meeting with some remarks on the question to be discussed:—What measures are necessary to secure efficiency and uniformity in the working of the sanitary laws throughout the kingdom? He drew especial attention to the want of anything like central authority for health-matters in the offices of the Government. He pointed out the different health-functions performed by the Registrar-General, the Poor Law Board, the Home Secretary, and the Privy Council; also the various local boards, such as vestries, boards of guardians, corporations, town councils, and sanitary committees, which were organized to carry into effect the multitudinous and contradictory Acts of Parliament, which proposed to give some people permission to preserve the health and life of others. Three papers were read on the general question: the first by W. H. Michael, Esq., the second by Dr. Elliott, of Carlisle, and the third by W. B. Caulfield, Esq. A very interesting discussion followed the reading of the papers. Dr. Stephenson McAdam, of Edinburgh, said that an Act had been passed for Scotland during the last session of Parliament, putting it in the power of any ten inhabitants to complain of nuisances, and also enabling them to insist on the local authority performing the necessary works, and compelling the owners of the property to pay for them. Dr. Browne stated they had no health officer for Belfast. Dr. Trench defended the action of the Corporation of Liverpool in health-matters, and thought their fault was a tendency to do too much in that direction. The result of the discussion was in favour of some plan by which there should be a central board or officer having a power of watching over the health-interests of the whole population. Every speaker was in favour of appointing medical officers of health for both town and country districts. Several of the speakers expressed themselves very strongly on the difficulty of proceeding in certain cases of nuisance under the various health-acts. Dr. Morris, of Baltimore, U.S., surprised the meeting somewhat by stating that they had no sanitary laws in America, and that the inhabitants of the large towns of America carried out all necessary sanitary actions of their own accord. In Baltimore, for instance, they had a board of health composed entirely of medical men, who, by the sanction of the inhabitants, exercised quite arbitrary powers. The board appointed two medical men as health-officers, and every policeman was made an inspector of nuisances. Whenever the police discovered a nuisance they reported to the officer of health, and legal steps were then taken, if necessary, to remove the nuisance, but there was no imperial authority in sanitary matters.

On Friday the question submitted for discussion was, "In what respects do the Registration Systems of England, Ireland, and Scotland need improvement, and is it desirable they should be assimilated?" This question was opened by an excellent paper from Dr. Arthur Ransome, of Manchester. After alluding to the system of registration of births and deaths, and the census-returns of the Registrar-General, he pointed out the uncertainty of the results, as far as life and health were concerned, founded upon such data. He dwelt more particularly on the disturbing elements of immigration and emigration in the large towns of England and in counties, the importation of young life increasing largely the death-rate of some districts. He suggested that, in addition to the information already obtained, the duration of the residence of the persons in the district in which they died should be recorded. He pointed out that in England neither the registration of births nor that of deaths was compulsory, and showed the unsatisfactory nature of the returns of causes of death obtained by voluntary means. He urged also the necessity of registering the births of still-born children, as crime might be extensively committed under the present system. He concluded by recommending that a registration medical officer should be appointed in each superintendent-registrar's district, whose duty it should be to verify death, who also might be the medical officer of health and the assessor in the coroner's court. Dr. Lankester gave some reasons for thinking it would be an especial advantage in the coroner's court to have as an assessor a person specially educated, whose duty it should especially be to conduct *post-mortem* examinations, and report upon them to the coroner and jury. Mr. Cengenven spoke of the defective registration of the births of illegitimate children, and stated as the result of his own inquiries that only 46 out of 140 illegitimate children were registered. He thought if a certificate of birth could be required before a burial-warrant was granted, that it might induce a larger number of registration of births.

Dr. McCrae, the Registrar of Belfast, stated that the poor registered the birth of their children more regularly than they did their death. He stated that in the Irish Registration Act there was no connection between the death and the burial, and the burial-warrant was not granted as the result of the registration of the death. The death was required to be registered within seven days, and the Registrar had power to demand a certificate, but many persons were buried, especially in country districts, without any registration or burial-warrant at all. Captain Clode, of the General Registrar's Office in London, stated that the causes of death were efficiently registered in London in 95 per cent. of all the deaths registered. In the country the proportion of deaths satisfactorily registered was much less. He stated with regard to compulsory registration that people in England regarded inquiries into domestic matters, such as births and deaths, as unnecessarily interfering with their private affairs, and it was in deference to this feeling that legislation had not proceeded further. At the conclusion of the discussion the chairman, Dr. Lankester, was requested to bring before the Council of the Association the deficiencies of the English Registration Act in relation to compulsory registration of births and deaths, and also the necessity for requiring in Ireland a medical certificate of the cause of death before permission was given to bury the body.

On Saturday Dr. Lankester read a paper on "Prison and Workhouse Dietaries."

On Monday the question discussed in the Health Section was, In what form and to what extent is it desirable that the public should provide means for the recreation of the working men? This question was opened by a paper from Dr. Hardwicke, of London. In the course of his remarks he recommended that public parks should be formed for the purposes of recreation, more especially for the sedentary classes of the population. Reading rooms, with indoor amusements, were better adapted for those who had been engaged in open-air occupations. He urged the necessity of recreation being encouraged on the Sunday, and recommended that reading rooms be opened, and lectures be given on that day. He suggested the formation of parks, working men's clubs, and other places of recreation to be supported out of the rates of the parish. A paper was also read by Miss Barham Corlett, in which she strongly recommended the formation of city playgrounds for children. A long discussion followed, in which various opinions were expressed as to the best way of providing the means of recreation. Mr. McAdam said that in Edinburgh the science classes, in connection with the School of Art, had succeeded. Mr. Airlie, of Glasgow, maintained that the working man needed amusement rather than instruction, and that in Glasgow weekly concerts and soirées had perfectly succeeded. Dr. Burtlett thought the working man should be allowed at his club to take a limited quantity of beer if he wished. Dr. Lankester advocated the introduction of unfermented beverages in our public parks. To drink was a very natural desire, and men were not satisfied with cold water, especially where it was dangerous, and he thought the teetotalers ought to devise some refreshing beverage that was palatable, and could be sold at the same price as London porter.

Sir James Simpson, Chairman of the Health Section, delivered his address on Tuesday Morning. There was a crowded audience.

The address was delivered extemporaneously. He began by describing man as the only animal that surrounded himself with filth and dirt, and by his own neglect shortened those days of existence which his Creator intended him to enjoy. He dwelt with great energy on the necessity of all classes, high as well as low, seeking to surround themselves with an atmosphere of pure air. He showed the dreadful effects of this neglect by the long list of preventable diseases which carried off people in England and Ireland, and which amounted to a number of not less than 120,000 persons annually in the three kingdoms. He showed how the houses of the rich as well as the poor were poisoned by the neglect of drainage and ventilation. He then drew attention to the mortality of hospitals as an illustration of the danger of impure atmospheres. He said the mortality of infants and mothers in lying-in hospitals was seven times as great as out of hospitals. He adduced statistics to show that in medical and surgical hospitals the death was much greater than in the humblest homes. He brought forward the experience of the American war in favour of the treatment of soldiers in camps and in temporary hospitals, as compared with the more costly and permanent kinds of hospitals. He then advocated the system of building Village Hospitals, in which not more than one or two cases should be treated in the same room. The subject of Smallpox was next referred to; and the fact alluded to, that 25,000 people had died of smallpox in the United Kingdom during the past four years. He considered this a disgrace to the intelligence and humanity of the country. He was afraid that we were barbarous enough to admire more those who destroyed the lives of our fellow-creatures than those who saved them. France had erected a monument to the memory of Jenner, that greeted every Englishman when he planted foot on her shores; and England had once set up a statue to Jenner, and placed it with her military heroes in Trafalgar Square, but had now allowed it to be cast away nobody knows where. No wonder that the Government which could thus insult the memory of Jenner, should allow the country to be smitten with the disease he had shown them how to prevent.

The remainder of Tuesday was employed in the discussion of the sanitary condition of Belfast. From two papers that were read, one by Dr. Browne and the other by Mr. Penworth, both of Belfast, it appears that this town is much in need of sanitary improvement. It appears that the death-rate was last year from 30 to 33 in the thousand. Accurate statistics cannot be got in Ireland, for reasons that have already been referred to in this report. The water is bad, the drainage is defective, the houses are overcrowded, the graveyards are full; and thus Belfast offers one of the finest fields in the United Kingdom for the exertion of sanitary philanthropy.

At the same time it might be mentioned that Belfast is about to be improved. Instead of taking part of its water from the filthy Lagan, it is about to extend its waterworks, so as to get pure water from the limestone hills with which it is surrounded. It is about to shut up its out-door graveyards, and to open a park for the recreation of the people. If the Social Science Congress should do nothing more than quicken the authorities of Belfast in their intentions to save their population from the suffering and death with which it is now afflicted, it will have done a work which will give it strong claims on the regard and sympathy of Belfast as long as it shall be a city where human beings are striving to realize the highest blessings of a kind Providence.

Quarterly List of Publications received for Review.

1. British Conchology; or, an Account of the Mollusca which now inhabit the British Isles and the surrounding Seas. Vol. IV. Marine Shells. By John Gwyn Jeffreys, F.R.S., F.G.S. Post 8vo., cloth. 487 pp. *With nine Plates.* *Van Voorst.*

2. Sound. A Course of Eight Lectures delivered at the Royal Institution of Great Britain. By John Tyndall, LL.D., F.R S. 340 pp. Post 8vo. 169 *Wood Engravings.* *Longmans & Co.*

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Acrodus,[*] the *Sphærodus*,[†] the *Saurocephalus*,[‡] the *Dendrodus*,[§] the *Labyrinthodon*,[‖] the *Iguanodon*,[¶] and the *Megatherium*,[**] in illustration of the value of Fossil remains, and of the microscope, as an instrument in the determination of their nature and affinities.

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"The present work would, however, have been very incomplete, if I had not been privately aided by the liberal contributions of teeth of rare fossil and recent animals, which were not available for the purpose of microscopic examinations when present in public collections.

"My grateful acknowledgments are more especially due to the PRESIDENT and COUNCIL of the ROYAL COLLEGE OF SURGEONS: for to them I owe the appointments which have made the pursuits most congenial to my tastes a duty, and at the same time have supplied the best means and opportunities of fulfilling it. In whatever degree, therefore, I may have contributed in this or previous works to the advancement of Comparative Anatomy, or may have aided in its application to collateral sciences, I can only regard myself as instrumental, in such measure, in carrying out the great objects which the College of Surgeons had in view in accepting the important trust of the Hunterian Museum, and which the College has ever since most strenuously promoted."—*Preface.*

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[*] Pl. 14.
[†] Pl. 32.
[‡] Pl. 55.

[§] Pl. 62 B. The teeth of this extinct Fish afford a beautiful example of the unexpected application of microscopic characters of dental tissue in the determination of an important geological problem.—See Appendix to Mr. Murchison's 'Geology of Russia,' p. 635.

[‖] Pl. 64 A.
[¶] Pl. 71.
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